

**ACCESSIBILITY EVALUATION OF THE BRIMO  
MOBILE BANKING APPLICATION  
FOR VISUALLY IMPAIRED**



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**SUPERVISOR ENDORSEMENT PAGE**

**ACCESSIBILITY EVALUATION OF THE BRIMO  
MOBILE BANKING APPLICATION  
FOR VISUALLY IMPAIRED**

**UNDERGRADUATE THESIS**



Yogyakarta, April 28<sup>th</sup>, 2026

Advisor,

( Chanifah Indah Ratnasari, S.Kom., M.Kom. )

## EXAMINER ENDORSEMENT PAGE

# ACCESSIBILITY EVALUATION OF THE BRIMO MOBILE BANKING APPLICATION FOR VISUALLY IMPAIRED

## UNDERGRADUATE THESIS

Has been defended in front of the examiners as one of the requirements to obtain a Bachelor of Informatics degree from the Undergraduate Program in Informatics at the Faculty of Industrial Technology, Universitas Islam Indonesia

Yogyakarta, May 25<sup>th</sup>, 2026

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### **ACCESSIBILITY EVALUATION OF THE BRIMO MOBILE BANKING APPLICATION FOR VISUALLY IMPAIRED**

Stating that all components and contents in this final project are my own work. If in the future it is proven that some parts of this work are not my own work, the final project submitted as my own work is ready to be withdrawn and ready to bear any risks and consequences.

Thus this statement letter is made, hopefully it can be used properly.

Yogyakarta, May 25<sup>th</sup>, 2026



( Fatin Maetam )

## DEDICATION

This work is dedicated, first and foremost, to Allah *Swt.*, a humble expression of gratitude and devotion from a servant who owes everything to His grace. To my parents, whose love never wavered, whose prayers never ceased, and whose sacrifices made this journey possible, this is as much yours as it is mine. And to the supporter who walked alongside me through every late night, every struggle, and every small victory of these undergraduate years, thank you for making the path worthwhile.

**MOTTO**

إِنَّ اللَّهَ مَعَ الصَّابِرِينَ

“Indeed, Allah is with the patient.”

## FOREWORD

In the name of Allah Swt., the Most Gracious and the Most Merciful. All praise and gratitude belong to Him alone, whose blessings and guidance made the completion of this final project possible. Prayers and peace be upon the Prophet Muhammad, saw., whose wisdom continues to illuminate the path of those who seek knowledge.

This final project report, entitled "Accessibility evaluation of the Brimo mobile banking application for visually impaired" was written as the fulfillment of one of the requirements for completing the undergraduate program. It is the author's sincere hope that this work carries meaning not only as an academic milestone but as a small yet genuine contribution to a more inclusive and accessible world.

The journey of this research was not without its challenges. One of the most significant was the unfamiliarity of navigating toward communities the author had never encountered before, the communities of visually impaired individuals, whose worlds had previously been unknown. Yet what began as uncertainty slowly transformed into one of the most profound experiences of this research. In seeking them out, the author found people of remarkable warmth, resilience, and perspective, people who did not merely participate in this study but who quietly changed the way the author sees the world.

This work would not have been possible without the presence and support of extraordinary individuals, to whom the author wishes to express the deepest gratitude:

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10. And finally, to the author, Fatin Maetam, for enduring, for persisting, and for choosing to keep going when it would have been easier not to. This is for you, too.

The author is fully aware that this final project is far from perfect, whether in its structure, analysis, or manner of expression. With humility, the author welcomes any constructive criticism and thoughtful suggestions from readers, which will serve as a meaningful reference for growth and improvement. It is the author's sincere hope that this work may broaden the reader's understanding and make even the smallest contribution to the advancement of knowledge, particularly in the pursuit of a world more accessible to all.

Yogyakarta, May 25<sup>th</sup>, 2026

A handwritten signature in black ink, appearing to read 'Fatin' with a stylized flourish at the end.

( Fatin Maetam )

## ABSTRACT

This study evaluates the accessibility of the BRImo mobile banking application for visually impaired users, benchmarked against WCAG 2.1 Level AA within the Android TalkBack screen reader environment. Despite BRImo's growth to over 45.9 million users by 2025 and Indonesia's legal mandates under Law No. 8 of 2016 on Persons with Disabilities, accessibility research on Indonesian mobile banking applications for visually impaired users remains limited, particularly in authentic screen reader environments. To address this gap, a mixed-methods evaluation of seven core BRImo features was conducted: login, balance checking, fund transfer, mobile top-up, transaction history, e-wallet top-up, and QRIS payment.

The evaluation employed two phases. Phase one involved a systematic TalkBack accessibility inspection across all seven features. Phase two (User Testing A) engaged six visually impaired participants: four totally blind and two low-vision. Using the think-aloud protocol, a structured evaluation matrix, semi-structured interviews, and the System Usability Scale (SUS).

All six User Testing A participants achieved 100% task completion; however, this outcome reflects task persistence rather than accessible design. Significant barriers were identified across multiple WCAG 2.1 dimensions, including inadequate screen reader labeling, navigation elements rendered as unintelligible strings, missing semantic structure in transaction history, insufficient color contrast, undersized touch targets, and non-scalable text units. WCAG 2.1 conformance assessment revealed that most evaluated success criteria were only partially satisfied, indicating substantive accessibility deficiencies in the current application. The original application recorded a mean SUS score of 84.17. In Indonesia, this study provides a replicable evaluation methodology for mobile banking accessibility and actionable WCAG 2.1 recommendations for BRImo developers.

**Keywords:** UI/UX accessibility, mobile banking, visually impaired users, TalkBack, WCAG 2.1, screen reader, usability testing, inclusive design.

## GLOSSARY

|                                                     |                                                                                                                                                                                                                                                   |
|-----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Accessibility                                       | The design of products, devices, services, or environments for people with disabilities, ensuring equal access and usability regardless of ability level.                                                                                         |
| Low Vision                                          | A visual impairment that cannot be fully corrected with glasses, contact lenses, medication, or surgery; includes conditions such as cataracts, glaucoma, and diabetic retinopathy.                                                               |
| Screen Reader                                       | Assistive technology that converts visual interface elements into synthesized speech or Braille output, enabling blind and visually impaired users to navigate and interact with digital devices.                                                 |
| System Usability Scale (SUS)                        | A widely validated, ten-item Likert scale questionnaire that provides a standardized, quantitative measure of perceived usability, with scores ranging from 0 to 100.                                                                             |
| TalkBack                                            | The built-in screen reader service for Android devices, developed by Google, that provides spoken feedback, gestures, and keyboard navigation for blind and visually impaired users.                                                              |
| WCAG 2.1 (Web Content Accessibility Guidelines 2.1) | An internationally recognized set of guidelines released in June 2018, adding 17 success criteria specifically addressing mobile accessibility, low vision, and cognitive disabilities; used as the primary evaluation standard in this research. |

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## CHAPTER I

### INTRODUCTION

#### 1.1 Background

The widespread adoption of smartphones and mobile internet connectivity has fundamentally reshaped the landscape of financial service delivery in Indonesia. Mobile banking applications have emerged as a primary channel through which individuals conduct everyday financial activities, encompassing balance inquiries, fund transfers, bill payments, and mobile top-up purchases, without the necessity of visiting physical bank branches (Nuramalina et al., 2025). The scale of this transformation is considerable by August 2025, digital banking transactions in Indonesia reached 17.74 million transactions valued at IDR 64,316.79 trillion (CNBC Indonesia, 2025), and Indonesia now leads Southeast Asia with 17 operational digital banks, reflecting the country's sustained commitment to digital financial modernization (S. S. Shah, 2024). Generational shifts have further accelerated this trajectory, as Generation Z has become a pivotal driver of digital economic participation, prompting conventional banking institutions to accelerate their transition toward fully digital service models (Fadli et al., 2024).

BRImo, the mobile banking application of PT Bank Rakyat Indonesia (Persero) Tbk, stands as one of the most prominent manifestations of this growth, expanding from 2.9 million users at its launch in 2019 to 45.9 million users by the close of 2025, processing 5.60 billion transactions totaling IDR 7,057 trillion within that year alone (Liputan6.com, 2026). BRImo was selected as the subject of this study for three interconnected reasons. First, as Indonesia's most widely adopted mobile banking application, it represents the digital banking experience of the broadest cross-section of the Indonesian population, including visually impaired users who have no realistic alternative within the BRI ecosystem, a need confirmed by this study's participant recruitment, which identified four visually impaired individuals in Yogyakarta who were existing BRImo users regularly attempting banking tasks via TalkBack. Second, BRI's status as a state-owned enterprise places it under a heightened obligation to comply with Law No. 8 of 2016 on Persons with Disabilities, which mandates accessible information and communication technology for all citizens. Third, a preliminary TalkBack inspection conducted during the pilot phase of this study identified initial indicators of significant accessibility failures across BRImo's core features, including unlabeled buttons, unintelligible navigation elements, and missing semantic structure, providing empirical grounds for a

systematic investigation. No prior peer-reviewed study has evaluated BRImo's accessibility for visually impaired users through authentic TalkBack interaction, making it both a practically significant and academically underexplored case.

Nonetheless, the swift proliferation of mobile banking has not consistently resulted in financial inclusion. Approximately 97.74 million Indonesian adults, roughly 48% of the adult population, remain unbanked, underscoring persistent structural barriers to financial participation (Setiawan et al., 2021). These disparities are especially pronounced among persons with disabilities, of whom only approximately 24.3% hold bank accounts, a figure markedly lower than the general population (Ebirim & Odonkor, 2024). Indonesia's disability population is substantial, estimated at approximately 26 million individuals (BPS, 2021; Fuentes et al., 2022), among whom visual impairment constitutes the most prevalent category. A multi-province Rapid Assessment of Avoidable Blindness (RAAB) survey estimated the total number of visually impaired Indonesians at approximately 8.02 million, comprising 1.65 million individuals who are blind and 6.36 million experiencing moderate to severe visual impairment (Rif'Ati et al., 2021). This population represents a significant and underserved segment of potential mobile banking users whose capacity for independent financial participation is contingent upon the accessibility of digital applications. Importantly, accessibility needs differ substantially across these subgroups: totally blind users depend entirely on TalkBack's audio output with no recourse to visual information, while low-vision users may supplement TalkBack with screen magnification or high-contrast display distinctions that this study accounts for in both participant selection and evaluation analysis.

Visually impaired users in Indonesia rely predominantly on TalkBack, Android's integrated screen reader, to navigate mobile interfaces. TalkBack functions by audibly announcing interface elements as users swipe sequentially through the screen, with interactions executed through double-tap gestures. For TalkBack to convey accurate and meaningful information, every interactive and informational element within an application must be descriptively labeled, logically sequenced, and semantically structured. When these conditions are absent, for instance, when buttons are announced only as "Tombol" (button) without descriptive context, or when currency abbreviations are mispronounced due to inadequate localization, independent navigation of financial applications becomes practically unachievable for blind users.

The internationally recognized framework for evaluating digital accessibility is the Web Content Accessibility Guidelines (WCAG) 2.1, published by the World Wide Web Consortium

(W3C) in 2018. Although originally developed for web-based content, WCAG 2.1 is equally applicable to native mobile applications. The guidelines are structured around four foundational principles: Perceivable, Operable, Understandable, and Robust (POUR), and Level AA compliance is broadly accepted as the minimum standard for accessible digital services (W3C WAI, 2024). Empirical evidence from international contexts demonstrates that compliance with these standards remains widely inadequate in the banking sector. A study examining Saudi Arabian banking applications found that none of the evaluated applications met WCAG 2.1 standards, with violations of the operable principle accounting for approximately 37% of all identified failures (Alayed, 2024). A Brazilian investigation identified 653 accessibility violations across four banking applications, with an average of 7.72 errors per screen, predominantly involving absent text descriptions for interface elements (Lopes et al., 2022). These findings suggest that accessibility deficiencies in mobile banking are systemic rather than isolated.

In the Indonesian context, these technical shortcomings carry direct legal and policy implications. Law No. 8 of 2016 on Persons with Disabilities explicitly guarantees the right of disabled individuals to access information and communication technology, while the National Strategy for Financial Inclusion (Strategi Nasional Keuangan Inklusif/SNKI) mandates equitable financial access for all citizens, including those with disabilities. Ensuring accessibility in widely adopted applications such as BRImo is therefore not merely a matter of technical compliance, but a legal obligation and a prerequisite for meaningful digital inclusion.

Despite these imperatives, empirical research on the accessibility of Indonesian mobile banking applications remains limited. Existing studies have predominantly focused on Western contexts and have largely relied on automated testing methodologies that capture only a subset of real-world accessibility barriers encountered by screen reader users. Feature-level evaluations conducted through authentic screen reader interaction, particularly within the linguistic and cultural specificities of the Indonesian banking environment, are notably absent from the literature. This study addresses these gaps by conducting a comprehensive, feature-by-feature accessibility evaluation of BRImo using TalkBack and benchmarking against WCAG 2.1 Level AA.

## **1.2 Problem Statement**

Despite BRImo's position as Indonesia's dominant mobile banking application, its accessibility is limited for the estimated 8.02 million Indonesians with visual impairments, who

span a spectrum from total blindness to low vision. Each with distinct assistive technology needs remains critically unaddressed.

A preliminary TalkBack inspection of BRImo, conducted during the pilot phase of this research, revealed initial evidence of substantive accessibility failures: interactive buttons announced without descriptive labels, QRIS navigation elements rendered as unintelligible character strings, transaction histories lacking semantic structure. These barriers are not incidental; they reflect systematic deficiencies in how BRImo's interface communicates with the TalkBack screen reader, rendering independent completion of basic banking tasks practically unachievable for blind users.

The urgency of addressing these deficiencies is underscored by Indonesia's legal and policy framework. Law No. 8 of 2016 on Persons with Disabilities explicitly guarantees the right to access information and communication technology, and the National Financial Inclusion Strategy mandates equitable financial access for all citizens, including those with disabilities. Yet only approximately 24.3% of Indonesians with disabilities hold bank accounts, markedly below the national average, indicating that inaccessible digital interfaces constitute a concrete and persistent barrier to financial participation (Ebirim & Odonkor, 2024).

The research gap is equally pressing. International studies have documented systemic accessibility failures in mobile banking: no Saudi Arabian banking application evaluated by Alayed (2024) met WCAG 2.1 standards, and Lopes et al. (2022) identified an average of 7.72 accessibility errors per screen across four Brazilian banking applications. Yet empirical research on the accessibility of Indonesian mobile banking remains scarce. Existing work relies predominantly on automated scanning tools, which capture only a fraction of real-world barriers experienced through authentic screen reader interaction, and no prior study has conducted a feature-level WCAG 2.1 evaluation of BRImo using TalkBack with visually impaired participants. This study directly addresses that gap.

### **1.3 Research Questions**

This research is guided by one main research question and three supporting questions, each derived from the accessibility gaps and evaluation needs identified in the problem statement.

a. Main Research Question

How accessible is the BRIImo mobile banking application for visually impaired users when navigated using the TalkBack screen reader on an Android device, and to what extent does it conform to WCAG 2.1 Level AA?

b. Supporting Research Questions

1. RQ1: What specific UI/UX accessibility barriers are encountered by visually impaired users when navigating the core features of BRIImo, including login, balance checking, fund transfer, mobile top-up, transaction history, e-wallet top-up, and QRIS using the TalkBack screen reader?
2. RQ2: To what extent does the BRIImo application conform to the four core principles of WCAG 2.1 (Perceivable, Operable, Understandable, and Robust) as assessed through systematic TalkBack inspection?
3. RQ3: How do visually impaired users, including both totally blind and low-vision individuals, experience accessibility barriers when completing core banking tasks in BRIImo using TalkBack, and what real-world difficulties emerge that are not captured by inspection alone?
4. RQ4: What evidence-based recommendations can be derived from the evaluation findings to improve the UI/UX accessibility of BRIImo for visually impaired users in Indonesia?

## 1.4 Scope of Work

To ensure a focused and achievable study. This research is defined within the following boundaries.

a. Application and Platform

This study is confined to the BRIImo mobile banking application created by PT Bank Rakyat Indonesia (Persero) Tbk. TalkBack is Android's built-in screen reader service, and the TalkBack accessibility inspection and user testing sessions are only done on Android. This research does not cover the iOS platform or other screen readers like VoiceOver (Apple) or NVDA (Windows).

b. Features Evaluated

The evaluation covers the following seven core features of BRIImo:

1. Login page (BRI Login)
2. Account balance checking (BRI Cek Saldo)

3. Domestic fund transfer (BRI Transfer)
  4. Mobile credit and data top-up (BRI Top-up > Pulsa/Data)
  5. Transaction history (BRI Riwayat Transaksi)
  6. Electronic wallet top-up (BRI Top-up > E-Wallet)
  7. QRIS payment and transfer (BRI Q-RIS)
- c. Exclusions

This research does not include: (a) evaluation of BRImo features beyond the seven listed above; (b) testing on iOS or with screen readers other than TalkBack; (c) a comparative evaluation of BRImo against other Indonesian mobile banking applications; or (d) longitudinal tracking of accessibility changes across multiple BRImo application update cycles. The application interface language is Bahasa Indonesia.

## 1.5 Research Objectives

This research aims to evaluate the accessibility of the BRImo mobile banking application for visually impaired users against WCAG 2.1 Level AA within the Android TalkBack screen reader environment. The following specific objectives are pursued in direct alignment with the research questions:

- a. To conduct a systematic TalkBack accessibility inspection of BRImo across seven core features: login, balance checking, fund transfer, mobile top-up, transaction history, e-wallet top-up, and QRIS payment, documenting screen reader behavior for each interface element and identifying specific UI/UX barriers that prevent or impede independent navigation and task completion by visually impaired users.
- b. To assess the extent to which BRImo conforms to the Perceivable, Operable, Understandable, and Robust principles of WCAG 2.1 Level AA, using a multi-instrument evaluation approach comprising TalkBack navigation, automated scanning, color contrast analysis, and WCAG success criteria mapping.
- c. To conduct User Testing A with six visually impaired participants, four totally blind and two low vision, using the think-aloud protocol, structured evaluation matrix, semi-structured interviews, and the System Usability Scale, to validate inspection findings and document real-world accessibility barriers experienced by both blind and low-vision users when completing core banking tasks via TalkBack.

- d. To derive actionable, evidence-based recommendations for BRIImo developers and UI/UX designers that directly address the identified accessibility barriers in alignment with specific WCAG 2.1 success criteria violations documented through the evaluation.

## 1.6 Research Benefits

The results of this research are expected to benefit the following parties:

- a. For the Researcher

This research enables the application of theoretical knowledge regarding UI/UX accessibility, WCAG 2.1, and mobile application assessment in a practical setting. Engaging in inspection and user testing phases cultivates practical skills in accessibility assessment, inclusive design, and user-centered research methodologies pertinent to a professional career in UI/UX and inclusive technology design.

- b. For BRI and Application Developers

The results and suggestions furnish BRI and the BRIImo development team with targeted, evidence-based direction for recognizing and addressing accessibility obstacles within the application. Enhancing TalkBack compatibility and WCAG 2.1 compliance would broaden effective access to BRIImo for approximately 8.02 million visually impaired Indonesians and reinforce BRIImo's status as a genuinely inclusive digital banking platform.

- c. For Users with Visual Impairments

The primary beneficiary of this research is the community of visually impaired users. Enhanced accessibility in BRIImo, guided by feedback from visually impaired participants in User Testing A, would empower blind and low-vision individuals to autonomously verify their balance, transfer funds, recharge mobile credit, and perform other banking activities without the need for sighted assistance, thereby fostering increased financial independence and inclusion.

- d. For the Academic Community

This study enhances the scholarly discourse on mobile application accessibility assessment and inclusive design within the Indonesian framework. The two-phase methodology, which includes systematic TalkBack inspection and user testing, can act as a reference model for future research on the accessibility of other mobile banking or digital service applications in Indonesia, thereby enhancing the existing knowledge on inclusive design practices in developing nations.

## 1.7 Research Methodology

This research is executed across four sequential stages organized into two principal phases. The first phase encompasses a systematic TalkBack accessibility inspection of the current BRImo application across seven core features, evaluated against WCAG 2.1 Level AA success criteria. The inspection employs four complementary instruments: TalkBack screen reader navigation, documenting element announcements and reading order, Google Accessibility Scanner automated report generation, Color Contrast Analyzer measurement of color contrast ratios, and WCAG 2.1 Vendor Checklist conformance assessment, synthesizing all gathered evidence.

The second phase involves participatory user testing with visually impaired participants (User Testing A), conducted following a preliminary pilot study that informed application selection and instrument development. User Testing A involves six participants: four with total blindness and two with low vision who interact with the live BRImo application on their own Android devices using their preferred assistive technology configuration, including TalkBack-only, direct visual interaction, or a combination of both. User Testing A aims to validate and extend the inspection findings by observing participants interacting with BRImo under naturalistic conditions, capturing real-world accessibility barriers through the think-aloud protocol, evaluation matrix, semi-structured interviews, and System Usability Scale.

## 1.8 Thesis Organization

This thesis comprises five chapters, each focusing on a distinct facet of the research, organized as follows:

a. Chapter One – Introduction.

This chapter delineates the research background, problem statement, research questions, scope of the study, research objectives, advantages of the research, research methodology, and the comprehensive structure of the thesis.

b. Chapter II – Literature Review.

This chapter examines pertinent theories and previous studies regarding UI/UX accessibility, mobile banking applications, visual impairment, the TalkBack screen reader, and WCAG 2.1 guidelines.

c. Chapter III – Research Methodology.

This chapter delineates the two-phase research design: (1) a systematic TalkBack accessibility evaluation of the current BRImo application; (2) User Testing A involving six visually impaired participants utilizing the existing application. The procedures for data collection, criteria for participant selection, and the analytical framework of WCAG 2.1 are also delineated.

d. Chapter IV – Results and Discussion.

This Chapter presents a multi-instrument accessibility evaluation of the original BRImo application (pilot survey, automated scan, TalkBack inspection, WCAG 2.1 assessment, color contrast analysis, and User Testing A with six visually impaired participants), documenting critical barriers such as unlabeled buttons, unintelligible QRIS navigation, missing semantic structure, contrast failures, and undersized touch targets.

e. Chapter V – Conclusion and Suggestions.

This chapter summarizes key findings, answers the research questions, provides prioritized recommendations for BRImo developers, and discusses limitations and future research directions.

## **CHAPTER II**

### **LITERATURE REVIEW**

#### **2.1 Usability: Theoretical Foundations**

Usability is a key idea in human-computer interaction (HCI) that describes how well a product works for certain users to reach certain goals with satisfaction, effectiveness, and efficiency in a certain situation (Bevan et al., 2016). When it comes to mobile banking apps, usability has a direct effect on how many people use them, how long they stay with them, and how happy they are with digital financial services in general. As banks and other financial institutions put more money into mobile banking platforms, it has become very important to understand and measure usability in order to stay ahead of the competition and keep customers (Alayed, 2024).

##### **2.1.1 Nielsen's Usability Model**

Jakob Nielsen, a prominent figure in usability engineering, introduced a multidimensional model of usability that has established itself as the definitive framework for usability assessment. Nielsen's model lists five important parts of usability (Nielsen, 2012).

The first component, learnability, requires that the system enable users to accomplish basic tasks quickly upon their initial interaction with the application, a consideration of particular importance in mobile banking contexts where users typically receive no formal training before first use. The second component, efficiency, pertains to the speed and minimal effort with which experienced users can complete tasks. In mobile banking, efficient interaction design reduces transaction time and simplifies workflow navigation. The third component, memorability, addresses the degree to which users who have not engaged with the system for an extended period can readily restore their operational proficiency without the need to re-learn the interface, a dimension especially critical for banking applications that may be used intermittently. The fourth component concerns error prevention and recovery, requiring that the system minimize the occurrence of user errors and provide clear, actionable guidance for rectification when errors do occur. Given the financial consequences of errors in banking contexts, this dimension carries heightened significance. The fifth component, satisfaction, encompasses the subjective quality of the user's experience, including aesthetic preferences, emotional responses, and overall attitudes toward the interface.

Nielsen's model has been demonstrated to be applicable in mobile banking environments in recent research. A comprehensive analysis of the usability of mobile banking applications, which was conducted using usability dimensions that were consistent with Nielsen's framework, demonstrated that learnability (ease-of-learning) has a substantial impact on the overall usability of these applications (Rachel Pirie & Tambotoh, 2023). The study employed Partial Least Squares Structural Equation Modeling (PLS-SEM) to analyze data from mobile banking users in Indonesia, confirming that all five usability-related dimensions have a substantial impact on perceived usability. Learnability was identified as the most significant factor.

### **2.1.2 System Usability Scale (SUS)**

The System Usability Scale (SUS) was developed by John Brooke in 1986 at Digital Equipment Corporation as a quick and reliable tool for measuring the perceived usability of a system from the user's perspective (Brooke, 1996). Although originally designed for evaluating hardware and software systems, SUS has since been validated across a wide range of digital interfaces, including mobile applications, making it an appropriate instrument for the present study.

SUS consists of ten items presented on a five-point Likert scale ranging from "strongly disagree" to "strongly agree". The items alternate between positively and negatively worded statements to reduce response bias. Positively worded items, such as "I think that I would like to use this system frequently", are scored by subtracting one from the user's response. Negatively worded items, such as "I found the system unnecessarily complex," are scored by subtracting the user's response from five. The ten adjusted scores are summed and multiplied by 2.5 to produce a final composite score on a scale of 0 to 100 (Brooke, 1996).

SUS scores are interpreted against established benchmarks. Bangor et al. (2008) proposed an adjective rating scale in which scores above 80.3 correspond to excellent usability (Grade A), scores between 68 and 80.3 indicate good usability (Grade B to C), and scores below 68 suggest poor usability that warrants improvement. Scores above 70 are generally classified as acceptable, and scores above 85 are considered excellent (Peres et al., 2013). Despite producing a single composite score, SUS aligns meaningfully with Nielsen's five-component usability model discussed in the preceding section. The SUS score most directly reflects Nielsen's satisfaction component, capturing how the user feels about their overall experience while also indirectly reflecting efficiency and error frequency, as participants'

perceptions of complexity and awkwardness are shaped by the difficulties they encounter during task completion. In this study, SUS is therefore employed as the quantitative instrument that operationalizes Nielsen's usability framework into a measurable outcome, complementing the qualitative data gathered through the think-aloud protocol and semi-structured interviews during User Testing A.

### **2.1.3 Usability Evaluation Methods**

There are different ways to test usability, and each has its own pros and cons. Heuristic evaluation, created by Nielsen and Molich in 1990, is when experts look at an interface and compare it to known usability rules. User testing, on the other side, means watching real users do things with the system. For research centered on accessibility, a synthesis of expert assessment and user testing involving representative participants is advised, since automated tools cannot completely encapsulate the lived experiences of individuals with disabilities (Lopes et al., 2022).

In the context of users with visual impairments, usability and accessibility are inseparable yet distinct constructs. A system that is usable for the general population may be entirely inaccessible to visually impaired users who rely on assistive technologies such as screen readers, screen magnification, or alternative input methods. Conventional usability evaluation, which typically involves sighted participants performing tasks on standard interfaces, cannot detect the accessibility barriers that blind and low-vision users encounter when navigating the same interface through TalkBack audio output, sequential swipe navigation, and gesture-based interaction. A button that a sighted user activates instantly by tapping its visible label may be announced to a TalkBack user only as "Tombol" a generic term conveying no functional information, rendering it effectively inaccessible despite being visually present and operable. This research, therefore, extends beyond the assessment of general usability to evaluate the actual accessibility of BRIImo as experienced by visually impaired users interacting through assistive technology, recognizing that ease of use for the general population does not guarantee and may actively obscure the inaccessibility of the application for this user group. The distinction between usability and accessibility, and the necessity of evaluating both dimensions through disability-inclusive methods, underpins the entire methodological design of this study.

## 2.2 Digital Accessibility: Standards and Frameworks

Digital accessibility is the process of making digital products and services that people with different abilities and disabilities can use (W3C Recommendation, 2025). Accessibility includes a wide range of disabilities, such as hearing, sight, motor, cognitive, and speech disorders. In the context of mobile banking, accessibility means that everyone, no matter their level of ability, can use digital channels to do their own financial transactions, get account information, and keep track of their money.

Accessibility and usability are two different things, but they are related. Usability is about making products easy for everyone to use, while accessibility is about meeting the needs of individuals with disabilities. The "curb-cut effect" (Newell & Gregor, 2000) says that accessible design often makes things easier for everyone to use.

### 2.2.1 Web Content Accessibility Guidelines (WCAG) Overview

The World Wide Web Consortium (W3C) made the Web Content Accessibility Guidelines (WCAG) the global standard for making digital content accessible. The POUR framework (W3C Recommendation, 2025) is made up of four main ideas that make up WCAG.

a. Perceivable

Users are required to be able to see and understand information and user interface parts. This means that users must be able to see, hear, and feel the information being presented. They can't be able to see it at all.

b. Operable

All users should be able to use the user interface and navigate it. This principle talks about functions that need the user to do something.

c. Understandable

The information and how the user interface works must be easy to understand. This principle talks about being clear and predictable.

d. Robust

The content needs to be strong enough that a wide range of user agents, including assistive technologies, can reliably read it.

There are three levels of conformance in WCAG: Level A (the lowest level), Level AA (the standard level for most organizations), and Level AAA (the highest level for accessibility). Most digital services, including banking apps, should aim for Level AA conformance (W3C Recommendation, 2025).

### 2.2.2 Comparative Analysis of WCAG Versions: 2.0, 2.1, and 2.2

Since their initial publication, the Web Content Accessibility Guidelines have undergone three significant iterations. WCAG 2.0, which was released in 2008, established the fundamental POUR framework; however, it was released prior to the widespread adoption of touch-based interfaces and smartphones. The limitation was resolved by the introduction of 17 new success criteria in WCAG 2.1, which was published in June 2018. These criteria were designed to address mobile accessibility, low-vision support, and cognitive disabilities. In October 2023, WCAG 2.2 was published, and it added nine additional criteria that focused on cognitive accessibility and authentication. A comparative summary of the three versions across key dimensions is presented in Table 2.1.

Table 2.1 Comparative table of WCAG 2.0 vs. WCAG 2.1 vs. WCAG 2.2

Source: (Ribera et al., 2009; W3C Recommendation, 2025)

| Feature                | WCAG 2.0 (2008)                                                                             | WCAG 2.1 (2018)                                                                                                                                        | WCAG 2.2 (2023)                                                                                                                                                 |
|------------------------|---------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Total Success Criteria | 61                                                                                          | 78                                                                                                                                                     | 86                                                                                                                                                              |
| Level A Criteria       | 25                                                                                          | 30                                                                                                                                                     | 32                                                                                                                                                              |
| Level AA Criteria      | 13                                                                                          | 20                                                                                                                                                     | 23                                                                                                                                                              |
| Level AAA Criteria     | 23                                                                                          | 28                                                                                                                                                     | 31                                                                                                                                                              |
| New Criteria Added     | N/A (baseline)                                                                              | 17                                                                                                                                                     | 9                                                                                                                                                               |
| Criteria Removed       | None                                                                                        | None                                                                                                                                                   | 1 (4.1.1 Parsing)                                                                                                                                               |
| Primary Focus          | General web accessibility, keyboard navigation, color contrast, screen reader compatibility | Mobile accessibility, low vision, cognitive disabilities                                                                                               | Cognitive accessibility, motor disabilities, authentication                                                                                                     |
| Key Additions          | Foundational POUR framework                                                                 | 1.4.10 Reflow, 1.4.11 Non-text Contrast, 1.4.12 Text Spacing, 2.5.1 Pointer Gestures, 2.5.3 Label in Name, 2.5.5 Target Size (44×44px), 2.2.1 Timeouts | 2.4.11 Focus Not Obscured, 2.5.7 Dragging Movements, 2.5.8 Target Size (24×24px), 3.2.6 Consistent Help, 3.3.7 Redundant Entry, 3.3.8 Accessible Authentication |
| Mobile Coverage        | Limited                                                                                     | Comprehensive                                                                                                                                          | Enhanced                                                                                                                                                        |
| Cognitive Support      | Basic                                                                                       | Expanded                                                                                                                                               | Significantly expanded                                                                                                                                          |
| Backward Compatibility | Baseline                                                                                    | Fully backward compatible with 2.0                                                                                                                     | Fully backward compatible with 2.0 and 2.1                                                                                                                      |

As illustrated in Table 2.1, all WCAG 2.x versions maintain full backward compatibility, ensuring that conformance with a newer version simultaneously satisfies the requirements of all preceding versions. Among the additions introduced in WCAG 2.1, the success criteria most directly relevant to this research include content reflow at high zoom levels (1.4.10), non-text contrast for interface components (1.4.11), adjustable text spacing (1.4.12), single-pointer alternatives for gesture-based interactions (2.5.1), and the requirement that accessible names incorporate visible labels (2.5.3). While WCAG 2.2 represents a meaningful advancement in cognitive and motor accessibility, its most significant additions fall outside the primary scope of this study's evaluation framework.

### **2.2.3 Rationale for Selecting WCAG 2.1 in This Research**

The selection of WCAG 2.1 Level AA as the principal accessibility evaluation standard for this research is informed by seven converging considerations. First, concerning alignment with the mobile banking context, WCAG 2.1 was developed specifically to address the mobile accessibility limitations of its predecessor, WCAG 2.0, which was conceived prior to the widespread adoption of smartphones and touch-based interfaces. This study evaluates BRImo as a native Android mobile banking application, making WCAG 2.1's mobile-centric success criteria, including pointer gestures (2.5.1), label in name (2.5.3), and content reflow (1.4.10) directly and comprehensively applicable to the evaluation framework in a way that WCAG 2.0 cannot provide.

Second, with respect to coverage for low-vision users, this study involves participants with both total blindness and low vision, necessitating an evaluation standard that addresses the distinct perceptual requirements of both groups. WCAG 2.1 introduced several success criteria specifically targeting low-vision accessibility that were absent from WCAG 2.0, including non-text contrast (1.4.11), text spacing (1.4.12), and text resizing without content loss or reflow (1.4.4). These criteria are indispensable for evaluating the visual design accessibility dimensions of BRImo as experienced by low-vision participants.

Third, regarding regulatory and institutional compliance, WCAG 2.1 Level AA constitutes the prevailing standard referenced in legal and regulatory frameworks across multiple jurisdictions. The European Accessibility Act (EAA) and the European standard EN 301 549 both stipulate WCAG 2.1 Level AA as the required threshold for digital accessibility compliance. Similarly, the United States Department of Justice's ADA Title II ruling mandates adherence to WCAG 2.1 Level AA for state and local government digital services. Major

financial institutions, including Bank of America, have formally adopted WCAG 2.1 as their organizational compliance standard (Paul, 2023), lending the chosen standard direct institutional relevance to the banking domain examined in this study.

Fourth, from practical, contextual, and compatibility standpoints, three additional considerations support the selection of WCAG 2.1 over its successor. First, WCAG 2.2 was published in October 2023, and at the time of this research, Indonesian financial institutions are unlikely to have completed the organizational transition to this newer standard, meaning violations identified against WCAG 2.2 may fall outside current industry compliance expectations. Second, the WCAG 2.2 criteria are most pertinent to banking applications. Accessible authentication (3.3.8) and redundant entry (3.3.7) address interaction dimensions that fall outside the primary scope of this study's feature-level transactional evaluation of BRImo. Third, WCAG 2.1 maintains full backward compatibility with WCAG 2.0, ensuring that evaluation against this version simultaneously satisfies all foundational accessibility requirements of the earlier standard without omitting any institutionally recognized criteria.

Fifth, from a forward applicability perspective, the evaluation findings and methodological framework established through this research are directly transferable to future studies employing WCAG 2.2 as the evaluative standard. The feature-by-feature TalkBack screen reader inspection methodology developed in this study is fully compatible with WCAG 2.2 success criteria, facilitating subsequent comparative and longitudinal accessibility research as the newer standard achieves broader adoption within the Indonesian banking sector.

#### 2.2.4 WCAG 2.1 Level AA Success Criteria for This Research

Based on the selection of WCAG 2.1 Level AA. The following success criteria form the evaluation framework for this research are presented in Table 2.2.

Table 2.2 The success criteria from the evaluation framework

Source: (W3C Recommendation, 2025)

| Principle   | Success Criterion            | Level | Relevance to Visually Impaired Users     |
|-------------|------------------------------|-------|------------------------------------------|
| Perceivable | 1.1.1 Non-text Content       | A     | Text alternatives for images and icons   |
|             | 1.3.1 Info and Relationships | A     | Programmatic determination of structure  |
|             | 1.3.2 Meaningful Sequence    | A     | Correct reading order for screen readers |

|                |                              |    |                                             |
|----------------|------------------------------|----|---------------------------------------------|
|                | 1.4.3 Contrast (Minimum)     | AA | Text readability for low-vision users       |
|                | 1.4.4 Resize Text            | AA | Text enlargement up to 200%                 |
|                | 1.4.10 Reflow                | AA | Content reflow at 400% zoom                 |
|                | 1.4.11 Non-text Contrast     | AA | Contrast for UI components and graphics     |
|                | 1.4.12 Text Spacing          | AA | Adjustable text spacing properties          |
| Operable       | 2.1.1 Keyboard               | A  | Screen reader navigation compatibility      |
|                | 2.1.2 No Keyboard Trap       | A  | Ability to move focus away from components  |
|                | 2.4.3 Focus Order            | A  | Logical focus navigation sequence           |
|                | 2.4.6 Headings and Labels    | AA | Descriptive headings and labels             |
|                | 2.4.7 Focus Visible          | AA | Visible keyboard focus indicator            |
|                | 2.5.1 Pointer Gestures       | A  | Single-pointer alternative for gestures     |
|                | 2.5.3 Label in Name          | AA | Visible label in accessible name            |
| Understandable | 3.1.2 Language of Parts      | AA | Programmatic language determination         |
|                | 3.2.2 On Input               | A  | No automatic context changes on input       |
|                | 3.3.1 Error Identification   | A  | Text identification of input errors         |
|                | 3.3.2 Labels or Instructions | A  | Labels/instructions for user input          |
| Robust         | 4.1.2 Name, Role, Value      | A  | Programmatic determination of UI components |
|                | 4.1.3 Status Messages        | AA | Status messages announced by assistive tech |

### 2.2.5 WCAG Compliance in Mobile Banking

Studies have consistently shown that mobile banking apps often do not meet WCAG standards. According to a study of banking apps in Saudi Arabia, none of the apps met WCAG 2.1 standards. The Operable principle was the most frequently broken, accounting for about 37% of all violations. The Perceivable, Robust, and Understandable principles were also

broken (Alayed, 2024). The study, which included applications from AlRajhi, SNB, and Riyad banks, found that none of the applications fully met accessibility requirements, but AlRajhi's application did perform better than the others.

Accessibility audits of banking applications in other settings have also found many problems. An independent accessibility review of a major European bank's mobile app found problems with all four POUR principles. These included non-text content that didn't have alternative text (1.1.1), incorrect semantic structure (1.3.1), focus order problems (2.4.3), focus not being visible (2.4.7), labels that didn't have descriptive names (3.3.2), and status messages that weren't announced (4.1.3) (Nordea, 2025).

A study of the Kenyan banking sector found that 85.3% of visually impaired respondents thought that specific accessibility improvements would make their mobile banking experience much better. However, 77.2% said that there was no standard accessibility framework across banks (Kibera, 2025). The study found that policy and institutional gaps, technical and digital limitations, and design and platform inconsistencies were major causes of accessibility barriers.

## **2.3 User Experience (UX) in Mobile Banking**

User Experience (UX) includes everything about how a user interacts with a product, system, or service, such as their feelings, thoughts, preferences, perceptions, physical and mental responses, behaviors, and achievements before, during, and after use. Usability looks at how well and quickly a task can be done, while UX looks at a wider range of factors, including enjoyment, aesthetic appeal, and emotional engagement (Marques et al., 2021).

In mobile banking, UX has become a key differentiator because basic transactional features have become common. Studies have demonstrated that a favorable user experience (UX) enhances customer satisfaction, loyalty, and advocacy, whereas an unfavorable UX leads to application abandonment and a shift to competitors (Alayed, 2024).

### **2.3.1 Digital Affordance in Mobile Banking**

Originally put forth by Gibson (1979) in ecological psychology and later adapted to HCI by Norman (1988), the idea of affordance refers to the perceived and actual properties of an object that determine how it could be used. In digital environments, affordances are not intrinsic attributes but are interpreted by users according to their previous experiences and the visual and interactive signals presented by the interface (Vyas et al., 2006).

A study on digital affordance in mobile banking systems identified six functional categories where affordance design significantly impacts user experience: remittance, money transfer history, payment card registration management, personal asset management, estimated payment amount and usage details, and investment. The research utilized focus group interviews grounded in Nielsen's heuristic evaluation methodology, revealing that proficient affordance design allows users to instinctively identify information and execute tasks without direct guidance (Setiyawati & Bangkalang, 2022).

### **2.3.2 UX Design Guidelines for Mobile Banking**

Industry practice and established UX research have identified several design principles that are particularly critical for mobile banking applications. In order to reduce cognitive load, it is necessary for each screen to present only the most critical information and to decompose intricate financial workflows into discrete, manageable steps. This requirement is known as interface simplicity. The learning burden for new users is reduced, and memorability across sessions is supported by consistency across interface elements, terminology, and interaction patterns. In financial contexts, where uncertainty regarding transaction outcomes can induce substantial user anxiety, it is particularly crucial to provide immediate and unambiguous feedback for each user action. Applications must minimize error opportunities and offer clear corrective guidance when errors occur in order to ensure that error prevention and recovery mechanisms are robust, given the financial repercussions of transactional errors. Lastly, UX design must convey trustworthiness and security by means of transparent explanations of protective mechanisms and explicit indicators, without introducing unnecessary interaction complexity (Setiyawati & Bangkalang, 2022).

## **2.4 Visual Design for Low-Vision Users**

Visual design for users with low vision requires careful attention to perceptual and cognitive dimensions that extend beyond general interface design principles. The following considerations are particularly critical in ensuring that digital interfaces remain accessible to this user group.

### **2.4.1 Visual Design Principles for Low-Vision Users**

Accessible visual design for low-vision users is governed by four principal considerations. First, color contrast must be sufficient to ensure text legibility: WCAG 2.1

mandates a minimum contrast ratio of 4.5:1 for normal text and 3:1 for large text at Level AA, with a minimum of 3:1 required for non-text elements such as form controls and graphics (W3C Recommendation, 2025). Second, typography must employ sans-serif fonts with adequate letter and line spacing, and text must be resizable without loss of content or functionality. A requirement of particular importance for low-vision users who consistently require larger text than standard interface defaults provide. Third, layout and spacing must avoid cluttered arrangements that impede navigation for users employing screen magnification, with sufficient spacing between interactive elements and clear visual grouping of related information to support orientation and wayfinding. Fourth, information conveyed through color alone, such as using red for errors and green for success, must be supplemented with text labels or icons to ensure comprehensibility for users with color vision deficiencies or those relying on screen readers.

#### **2.4.2 Accessibility Needs of Low-Vision Users**

Low-vision users represent a heterogeneous group whose accessibility needs differ substantially from those of totally blind users. While blind users depend entirely on the screen reader output, low-vision users retain partial functional vision and interact through a combination of direct visual perception and assistive features such as screen magnification, high-contrast display modes, and enlarged text settings. This hybrid interaction mode means that visual design deficiencies, such as insufficient color contrast, non-scalable text, and cluttered layout density, can render interfaces effectively inaccessible to low-vision users even when screen reader compatibility is fully achieved to meet their accessibility needs. Therefore, span both the technical dimension of assistive technology compatibility and the perceptual dimension of visual design quality, necessitating evaluation instruments that address both simultaneously.

#### **2.4.3 Implications for Financial Applications**

Studies have pinpointed particular accessibility obstacles encountered by low-vision users in financial applications. Many mobile check deposit features don't have audio instructions that low-vision users need to line up checks correctly. This is because they rely heavily on camera functionality. Digital bank statements sent as unstructured PDFs may not be readable by screen magnification software, which means that users can't check their transaction records on their own (Gomes de Andrade et al., 2024).

#### **2.4.4 Color Contrast Analysis: Tools and Evaluation Methods**

Color Contrast Analysis (CCA) is a systematic evaluation method used to verify whether interface color combinations satisfy WCAG accessibility thresholds. Several tools support this process, including the Colour Contrast Analyser (CCA) developed by The Paciello Group, which enables evaluators to sample foreground and background colors directly from any screen element using an eyedropper tool and compare the resulting ratio against WCAG criteria (Sharma et al., 2024); WebAIM's Color Contrast Checker, which supports manual web-based evaluation; and the Android Accessibility Scanner, which performs automated contrast checking but is limited in its ability to detect all interface elements (Kochhar et al., 2015). Prior research in mobile banking accessibility has consistently identified color contrast failure as among the most prevalent violation categories. Lopes et al. (2022) identified contrast failures as the most common accessibility problem across four Brazilian banking applications, a finding echoed by an independent audit that identified 10,000 contrast-related WCAG failures in a single national bank's application. For users with conditions such as cataracts, glaucoma, or diabetic retinopathy, insufficient contrast can render interface content effectively inaccessible, underscoring the necessity of systematic contrast evaluation in any comprehensive mobile banking accessibility assessment (P. Shah et al., 2018).

### **2.5 Characteristics of Visually Impaired Users**

#### **2.5.1 Definition and Classification of Visual Impairment**

Visual impairment includes a wide range of conditions, from mild vision loss to complete blindness. Visual impairment is based on visual acuity and visual field. Moderate visual impairment: Visual acuity is worse than 6/18 but better than or equal to 6/60. Severe visual impairment means that your vision is worse than 6/60 but better than or equal to 3/60. Blindness is when your eyesight is worse than 3/60, or your field of vision is less than 10 degrees (Dandona & Dandona, 2006). Because people have different visual abilities, accessibility solutions need to meet a wide range of needs. Some users may only use screen readers like TalkBack (Android) or VoiceOver (iOS), while others may use screen magnification, high-contrast modes, or large text settings. Others may use a mix of these tools.

#### **2.5.2 Assistive Technologies for Mobile Banking**

Visually impaired users of mobile devices primarily rely on screen readers to interact with applications. On Android devices, TalkBack is developed by Google. Converts visual

interface elements into synthesized speech, enabling blind users to navigate and interact with applications through touch gestures and directional swipe commands. For TalkBack to function accurately, applications must provide descriptive accessible labels for all interactive and informational elements, maintain a logical focus order, and implement correct semantic structure so that the screen reader can convey the function and content of each element (Zhang et al., 2021). Users with low vision may additionally employ screen magnification, high-contrast display modes, or enlarged text settings, either independently or in combination with screen reader functionality. Applications must therefore support responsive layouts and system-level display preferences to remain accessible across this spectrum of assistive technology usage.

The accessibility needs of blind users and low-vision users differ substantially and necessitate distinct evaluation approaches within this research. Blind users rely exclusively on the screen readers such as TalkBack and are primarily affected by deficiencies in semantic structure, accessible labeling, logical reading order, and programmatic element relationships. Barriers such as unlabeled buttons, unintelligible navigation announcements, or transaction statuses conveyed only through color render an interface functionally inaccessible to blind users, regardless of its visual design quality. Low-vision users, in contrast, retain partial functional vision and interact through a combination of direct visual perception and assistive features including screen magnification, high-contrast modes, and enlarged text. Their accessibility experience is therefore more sensitive to color contrast ratios, text scaling behavior, touch target dimensions, and layout density than to screen reader label accuracy. This divergence directly motivates the methodological split in this study: User Testing A engages both blind and low-vision participants to evaluate TalkBack accessibility in the live BRImo application, while User Testing B focuses exclusively on low-vision participants to validate the visual design improvements in the prototype redesign.

### **2.5.3 Usage Patterns and Accessibility Challenges of Visually Impaired Users**

Empirical research has documented a range of accessibility barriers encountered by blind and low-vision users in mobile banking contexts. Many of which stem from design conventions developed exclusively for sighted users.

#### **a. Authentication Barriers**

Screen reader users encounter significant barriers when navigating visual CAPTCHAs, which present security verification challenges exclusively through visual cues that are

inaccessible to TalkBack's audio output, The Small touch targets for entering a PIN, and sessions that only last for a short time. Biometric authentication, such as fingerprint or facial recognition, might be easier to use (Oh et al., 2021).

b. Navigation Complexity

Complex menu structures and non-standard navigation patterns present significant comprehension challenges when interpreted exclusively through screen reader audio output, as users must sequentially traverse all interface elements without the spatial and visual overview available to sighted users. (Lopes et al., 2022).

c. Feedback Gaps

Insufficient auditory feedback upon action completion leaves users unable to confirm the outcome of their interactions, creating uncertainty that is particularly consequential in financial transaction contexts, like confirming a transaction. This can make them unsure if their actions worked.

d. PDF Inaccessibility

Digital statements and transaction histories sent as PDFs may not be properly tagged so that screen readers can read them (Wang et al., 2021).

e. Not enough user involvement

Persons with visual impairments are systematically underrepresented in product design and testing processes, resulting in applications that fail to address their real-world interaction needs despite being technically functional for sighted users (Leporini & Paternò, 2008).

## 2.6 Previous Research

This section presents a systematic review of prior empirical and theoretical studies directly relevant to the research themes of this study. The literature search was conducted using Google Scholar, ScienceDirect, and IEEE Xplore as primary databases. The following keywords and keyword combinations were employed: “mobile banking accessibility”, “WCAG 2.1 mobile application”, “visually impaired mobile banking, screen reader usability”, “TalkBack accessibility Android”, “low vision digital interface”, “inclusive design mobile application”, “usability accessibility disability mobile”, “aksesibilitas aplikasi mobile tunanetra”, “evaluasi UX difabel Indonesia”, and “inklusi digital perbankan disabilitas Indonesia”. The search was filtered from 2018 to 2026 to ensure relevance to the contemporary mobile accessibility landscape. The year 2018 was selected as the starting point because it

marks the introduction of WCAG 2.1, which serves as the primary accessibility framework guiding this study. Studies were selected based on direct relevance to at least one of the following themes: WCAG compliance evaluation of mobile applications, usability or accessibility testing with visually impaired or disabled participants, screen reader interaction in mobile contexts, visual design accessibility for low-vision users, prototype-based redesign for accessibility, and digital financial inclusion for persons with disabilities. A total of thirteen studies were identified as most relevant and are presented across three analytical frameworks below. Table 2.3 presents the thirteen reviewed studies categorized according to their primary research focus, enabling a systematic comparison of thematic coverage across the existing literature.

Table 2.3 Analysis framework based on the research topic and focus

| Author (Year)        | WCAG Compliance | Assistive Tech | Mobile Banking | Disability | Redesign | Indonesian Context | Brief Description                                                                                                      |
|----------------------|-----------------|----------------|----------------|------------|----------|--------------------|------------------------------------------------------------------------------------------------------------------------|
| (Alayed, 2024)       | ✓               | ✓              | ✓              | ✓          |          |                    | Mixed-methods WCAG 2.1 evaluation of three Saudi Arabian banking apps with 12 blind Arabic-speaking users              |
| (Lopes et al., 2022) | ✓               |                | ✓              |            |          |                    | Automated accessibility audit of four Brazilian mobile banking apps identifying 653 WCAG violations                    |
| (Kibera, 2025)       |                 |                | ✓              | ✓          |          |                    | Mixed-methods survey of 68 visually impaired mobile banking users in Kenya identifying systemic accessibility barriers |
| (Huq et al., 2026)   | ✓               | ✓              |                | ✓          |          |                    | Mixed-methods CHI study bridging automated intervention and real screen reader user experience on mobile               |

|                          |   |   |   |   |   |   |                                                                                                                      |
|--------------------------|---|---|---|---|---|---|----------------------------------------------------------------------------------------------------------------------|
| (Alajarmeh, 2022)        | ✓ |   |   | ✓ |   |   | Critical analysis of WCAG 2.1 success criteria sufficiency and conformance levels for visually impaired mobile users |
| (Khowaja et al., 2019)   | ✓ | ✓ |   | ✓ |   |   | Comparative study distinguishing accessibility from usability in user interfaces for visually impaired users         |
| (Kerdar et al., 2024)    | ✓ |   |   | ✓ | ✓ |   | Design analysis of visual accessibility principles for low-vision users in digital environments                      |
| (Adler et al., 2025)     |   |   |   | ✓ | ✓ |   | Co-design and heuristic evaluation of an mHealth prototype for people with disabilities                              |
| (Chinnaraju, 2025)       |   |   | ✓ |   |   |   | Quantitative PLS-SEM analysis of mobile banking UI/UX usability using Nielsen's model                                |
| (Ilyasa et al., 2023)    |   |   | ✓ | ✓ | ✓ | ✓ | Inclusive design of a mobile e-wallet for visually impaired users in Bandung, Indonesia                              |
| (Hardianti et al., 2024) | ✓ |   |   | ✓ |   | ✓ | Accessibility evaluation of Indonesian interactive learning mobile apps for users with intellectual disabilities     |
| (Masrur et al., 2022)    | ✓ |   |   | ✓ |   | ✓ | Systematic literature review of usability and accessibility evaluation of mobile applications for                    |

|                    |  |  |   |   |  |   |                                                                                                          |
|--------------------|--|--|---|---|--|---|----------------------------------------------------------------------------------------------------------|
|                    |  |  |   |   |  |   | people with disabilities, conducted in Indonesia                                                         |
| (Mutafarida, 2024) |  |  | ✓ | ✓ |  | ✓ | Study of accessibility and digital inclusion in Indonesian Islamic banking for persons with disabilities |

From the thematic analysis presented in Table 2.3, several observations can be drawn regarding the distribution of research focus across the reviewed literature. The theme most frequently addressed is accessibility or usability evaluation involving users with disabilities or visual impairments, appearing in ten of the thirteen studies, which reflects the growing scholarly recognition that disability-inclusive evaluation is essential for meaningful digital accessibility research. WCAG compliance assessment is addressed in eight studies, confirming its status as the dominant evaluative framework in both international and national accessibility research contexts. Seven studies cover mobile banking as an application domain, though only three of these, Alayed (2024), Ilyasa et al. (2023), and Mutaarida (2025), directly combine mobile banking with disability or visual impairment as their primary focus, underscoring the persistent scarcity of research at the intersection of these two domains.

Screen reader or assistive technology evaluation is explicitly addressed by only three studies: Alayed (2024), Huq et al. (2026), and Khowaja et al. (2019), despite screen readers being the primary means through which visually impaired users interact with mobile applications. This represents a notable methodological gap in the existing literature, as the majority of prior studies rely on automated scanning tools or heuristic evaluation rather than authentic screen reader interaction. Prototype-based redesign as a research output is present in only three studies: Hamideh Kerdar et al. (2024), Adler et al. (2026), and Ilyasa et al. (2023), indicating that evidence-based accessible redesign validated through user testing remains an underexplored area. Indonesian contextual studies account for four of the thirteen reviewed works, providing a foundational but limited body of national literature that this research seeks to expand. Table 2.4 categorizes the reviewed studies according to their primary research methodology, providing a comparative basis for evaluating the methodological landscape of accessibility and usability research in mobile application contexts.

Table 2.4 Analysis framework based on research methodology

| Author (Year)             | Research Approach | Evaluation Method                            | Participants                                             | Key Instruments                         | Limitation of Method                                            |
|---------------------------|-------------------|----------------------------------------------|----------------------------------------------------------|-----------------------------------------|-----------------------------------------------------------------|
| (Alayed, 2024)            | Mixed methods     | Manual WCAG inspection + usability testing   | 12 blind users                                           | Think-aloud, WCAG checklist, interview  | Small sample; Arabic-language context only                      |
| (Lopes et al., 2022)      | Quantitative      | Automated accessibility scanning             | None                                                     | Accessibility Scanner tool              | Cannot capture real user experience; misses contextual barriers |
| (Kibera, 2025)            | Mixed methods     | Survey + PCA + expert interview              | 68 visually impaired users, bank officials, tech experts | Questionnaire, PCA                      | No WCAG framework applied; no usability testing                 |
| (Huq et al., 2026)        | Mixed methods     | Automated intervention analysis + user study | Screen reader users                                      | Screen reader logs, user observation    | Focused on intervention gap, not redesign validation            |
| (Alajarmeh, 2022)         | Qualitative       | Document analysis + expert review            | Visually impaired users (indirect)                       | WCAG 2.1 criteria mapping               | Theoretical; no empirical user testing                          |
| (Khowaja et al., 2019)    | Comparative       | Heuristic evaluation + user testing          | Visually impaired users                                  | Accessibility and usability scales      | Limited to UI comparison; no banking context                    |
| (Kerdar et al., 2024)     | Qualitative       | Literature review + design analysis          | Low-vision users (indirect)                              | Visual design principles                | No empirical testing with real users                            |
| (Adler et al., 2025)      | Mixed methods     | Co-design + heuristic evaluation             | People with disabilities                                 | Co-design sessions, heuristic checklist | Healthcare domain; not mobile banking                           |
| (Chinnaraju, 2025)        | Quantitative      | Survey + PLS-SEM                             | General mobile banking users                             | Likert questionnaire, PLS-SEM           | No disability focus; no accessibility evaluation                |
| (Ilyasa et al., 2023)     | Mixed methods     | Inclusive design + prototype testing         | Visually impaired users                                  | Design thinking, prototype evaluation   | Single city; limited generalizability                           |
| (Hardiyanti et al., 2024) | Mixed methods     | Accessibility evaluation + user testing      | Users with intellectual disabilities                     | Accessibility checklist, observation    | Different disability type; not banking                          |
| (Masruroh et al., 2022)   | Qualitative       | Systematic literature review                 | N/A (secondary data)                                     | PRISMA, bibliographic analysis          | No primary data; synthesizes existing studies only              |

|                    |             |                                        |                                        |                             |                                                 |
|--------------------|-------------|----------------------------------------|----------------------------------------|-----------------------------|-------------------------------------------------|
| (Mutafarida, 2024) | Qualitative | Descriptive analysis + document review | Persons with disabilities (conceptual) | Policy and service analysis | No empirical usability or accessibility testing |
|--------------------|-------------|----------------------------------------|----------------------------------------|-----------------------------|-------------------------------------------------|

The methodological analysis presented in Table 2.4 reveals significant variation in how accessibility and usability research has been conducted across the reviewed literature. Studies can be broadly categorized into three methodological clusters. The first cluster comprises studies employing purely automated or document-based approaches, including Lopes et al. (2022), Alajarmeh (2022), Masruroh et al. (2022), and Mutafarida (2024). While these studies efficiently identify technical violations or synthesize existing knowledge, they share a common limitation in that they cannot capture the authentic lived experience of users with disabilities navigating real application interfaces. Lopes et al. (2022) explicitly acknowledge this constraint, recommending that automated testing be supplemented with manual inspection and participatory user testing to achieve a more complete picture of accessibility barriers.

The second cluster consists of studies using mixed-methods approaches that combine technical evaluation with direct user participation, including Alayed (2024), Kibera (2025), Huq et al. (2026), Adler et al. (2025), Ilyasa et al. (2023), and Hardiyanti et al. (2024). Among these, Alayed (2024) and Huq et al. (2026) are methodologically closest to the present study, as both employ real assistive technology users in authentic interaction scenarios and apply structured evaluation frameworks. These studies consistently demonstrate that mixed-methods approaches yield richer and more ecologically valid findings than single-method designs. The third cluster includes quantitative survey-based studies such as Arunraju Chinnaraju (2025), which generate statistically generalizable usability metrics but lack the observational depth required to identify specific screen reader interaction barriers.

Across all reviewed studies, no prior work was identified that combines systematic feature-level TalkBack screen reader inspection, participatory usability testing with visually impaired users, WCAG 2.1 compliance mapping, and prototype-based redesign validation within a single integrated research design. This methodological gap directly informs and justifies the three-phase mixed-methods design adopted in the present study. Table 2.5 summarizes the principal findings of each reviewed study and articulates their specific relevance to the present research, enabling a structured assessment of how existing knowledge informs and positions this study.

Table 2.5 Analysis framework based on key findings and relevance to current

| Author (Year)          | Key Findings                                                                                                     | Gap / Limitation                                               | Relevance to This Study                                                                                  |
|------------------------|------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| (Alayed, 2024)         | None of three Saudi banking apps fully met WCAG 2.1; Operable principle violations ~37%; AlRajhi performed best  | Arabic context only; no Indonesian or Bahasa Indonesia context | Primary international benchmark; methodology directly referenced for TalkBack inspection design          |
| (Lopes et al., 2022)   | 653 violations across 4 apps; 7.72 errors/screen; most common: missing text descriptions                         | Automated testing only; no real user involvement               | Supports rationale for combined manual and user testing; contrast study for methodology justification    |
| (Kibera, 2025)         | 85.3% of users believe targeted improvements would greatly help; three barrier categories identified             | No WCAG framework; no screen reader testing                    | Validates developing-country accessibility barrier dimensions; supports policy justification             |
| (Huq et al., 2026)     | Significant gap between what automated tools detect and what screen reader users actually experience             | Does not cover mobile banking or redesign validation           | Directly supports argument for real screen reader user testing over automated evaluation                 |
| (Alajarmeh, 2022)      | Several WCAG 2.1 success criteria are insufficient or inappropriately leveled for visually impaired mobile users | Theoretical only; no empirical testing                         | Informs critical interpretation of WCAG 2.1 conformance results in evaluation findings                   |
| (Khowaja et al., 2019) | Accessibility and usability are distinct constructs; high task completion does not equal accessible design       | No banking context; no screen reader                           | Provides theoretical grounding for the finding that 100% task completion does not indicate accessibility |
| (Kerdar et al., 2024)  | High contrast, sans-serif fonts, scalable text, and flexible spacing consistently preferred by low-vision users  | No empirical mobile banking testing                            | Directly informs visual design decisions in accessible prototype redesign phase                          |
| (Adler et al., 2025)   | Co-design with disabled users produces more contextually appropriate prototypes than expert-only design          | Healthcare domain; not mobile banking                          | Supports inclusive, user-validated approach to prototype redesign in Phase 3                             |
| (Chinnaraju, 2025)     | Learnability is the strongest usability predictor in mobile banking; intuitive first-use experience is critical  | No disability or accessibility focus                           | Supports adoption of Nielsen's usability dimensions as theoretical basis for evaluation matrix           |
| (Ilyasa et al., 2023)  | Inclusive design approach successfully produced an accessible e-wallet prototype for visually                    | Single-city scope; limited to e-wallet feature                 | Closest Indonesian study; validates inclusive design approach in Indonesian mobile financial services    |

|                           |                                                                                                                                         |                                            |                                                                                                             |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|-------------------------------------------------------------------------------------------------------------|
|                           | impaired users in Indonesia                                                                                                             |                                            |                                                                                                             |
| (Hardiyanti et al., 2024) | Indonesian learning apps showed multiple accessibility violations affecting users with intellectual disabilities                        | Different disability type and app domain   | Confirms that Indonesian mobile apps broadly fail accessibility standards; supports research gap argument   |
| (Masruroh et al., 2022)   | Existing research on mobile app accessibility for disabled users is fragmented; manual testing consistently outperforms automated tools | Secondary data only; no primary evaluation | Validates research design choice of manual TalkBack inspection combined with user testing                   |
| (Mutafarida, 2024)        | Indonesian Islamic banking services have not adequately addressed accessibility and digital inclusion for persons with disabilities     | No empirical usability or WCAG testing     | Directly supports research gap argument; confirms BRIimo accessibility is an unresolved institutional issue |

Collectively, the thirteen reviewed studies confirm that mobile banking accessibility failures are systemic across contexts, that automated testing alone consistently produces incomplete barrier identification, and that no prior study has combined systematic screen reader inspection, participatory user testing with visually impaired users, and prototype-based redesign validation within a single integrated research design. This compound absence particularly prevalent within the Indonesian mobile banking context. Establishes the necessity of the three-phase methodology adopted in this study.

The cross-study analysis presented in Table 2.5 reveals several convergent and divergent patterns across the reviewed literature. From a findings convergence perspective, studies consistently demonstrate that mobile banking and digital financial service applications in both developed and developing country contexts fail to meet established accessibility standards, with barriers most frequently manifesting in the dimensions of screen reader labeling, color contrast, touch target sizing, and semantic content structure. This pattern is observed across geographically diverse contexts, including Saudi Arabia, Brazil, Kenya, and Indonesia, suggesting that accessibility deficiencies in mobile financial applications are systemic rather than context-specific.

From a theoretical perspective, Khowaja et al. (2019) and Huq et al. (2026) collectively establish a critical distinction that is directly relevant to interpreting the findings of this study: task completion rates and perceived usability scores do not serve as reliable proxies for accessibility compliance. A user may complete a banking task through compensatory strategies

and persistent effort while simultaneously encountering significant accessibility barriers that increase cognitive load, extend task duration, and reduce independence. This distinction justifies the multi-instrument evaluation design of the present study, which combines task completion observation, System Usability Scale measurement, think-aloud protocol, and WCAG 2.1 compliance mapping rather than relying on any single metric.

From a methodological perspective, Masruroh et al. (2022) and Lopes et al. (2022) independently conclude that automated accessibility testing tools capture only a subset of real-world accessibility barriers, and that manual evaluation combined with authentic user testing is necessary to fully characterize the accessibility experience of users with disabilities. This convergent recommendation from both an Indonesian systematic review and an international empirical study provides strong dual-source justification for the TalkBack-based manual inspection and participatory user testing methodology adopted in this research.

The cross-study analysis presented above identifies three categories of research gaps that collectively motivate and justify the present study. The Contextual Gap: all identified studies evaluating mobile banking accessibility were conducted outside Indonesia, spanning Saudi Arabia (Alayed, 2024), Brazil (Lopes et al., 2022), and Kenya (Kibera, 2025). The four Indonesian studies identified by Ilyasa et al. (2023), Hardiyanti et al. (2024), Masruroh et al. (2022), and Mutafarida (2024) confirm that accessibility remains inadequately addressed in Indonesian digital services broadly, but none specifically evaluate a major Indonesian mobile banking application against WCAG 2.1 using authentic screen reader interaction. The linguistic dimension of this gap is equally significant: Bahasa Indonesia text-to-speech rendering, locally specific currency pronunciation, and culturally embedded banking conventions present accessibility challenges that Western-developed evaluation frameworks do not adequately capture.

Methodological Gap is that the majority of reviewed studies rely on automated accessibility testing tools that, as Lopes et al. (2022) and Masruroh et al. (2022) independently confirm, capture only a subset of real-world accessibility barriers encountered by screen reader users. Studies that involve real assistive technology users, such as Alayed (2024) and Huq et al. (2026), confirm that the gap between automated detection and actual screen reader user experience is substantial. Furthermore, no prior study was identified that combines systematic feature-level TalkBack screen reader inspection, participatory usability testing with visually impaired users, WCAG 2.1 compliance mapping, and prototype-based redesign validation within a single integrated research design.

Practical Gap. BRImo, with 45.9 million users as of 2025, is the most widely used mobile banking application in Indonesia. Despite its national significance and the legal mandates established by Law No. 8 of 2016 on Persons with Disabilities, no empirical accessibility evaluation of BRImo for visually impaired users has been published in any academic venue. Indonesian financial institutions, therefore, lack the empirical evidence necessary to identify, prioritize, and remediate accessibility barriers in a structured and standards-aligned manner, a gap this study directly addresses through its three-phase evaluation and redesign methodology.

## 2.7 Conceptual Framework

This study employs a conceptual framework that synthesizes Nielsen's usability model, WCAG 2.1 accessibility guidelines, and user experience principles tailored for visually impaired users of mobile banking applications, as derived from the reviewed literature. The framework posits that accessible mobile banking for visually impaired users is determined by four interconnected dimensions that collectively shape the user's capacity for independent and satisfactory digital financial participation.

The first dimension concerns usability, operationalized through Nielsen's five components. This encompasses the learnability of core banking tasks upon initial interaction, the efficiency with which transactions can be executed following familiarization, the memorability of navigation structures across intermittent usage sessions, the system's capacity to prevent and support recovery from errors, and the overall subjective satisfaction experienced by the user throughout the interaction.

Structured around the four POUR principles, the second dimension pertains to WCAG 2.1 accessibility compliance. Assistive technologies must provide access to all informational and interactive content, including text alternatives for non-text content, adaptable content presentation, and sufficient distinguishability of foreground and background elements, in accordance with the Perceivable principle. According to the Operable principle, all functionality must be accessible through screen reader navigation, with logical focus sequencing, sufficient interaction time, and appropriate input modalities. The principle of Understandable necessitates that input assistance be provided to prevent and correct errors, interface behavior be predictable, and textual content be readable. The Robust principle necessitates that content be sufficiently well-structured to be reliably interpreted by current and future assistive technologies, such as TalkBack on Android.

The third dimension focuses on visual design accessibility for low-vision users, addressing the specific perceptual requirements of users who retain partial vision. This dimension encompasses color contrast ratios meeting WCAG 2.1 thresholds for text (1.4.3) and non-text elements (1.4.11), text resizability without loss of content or functionality (1.4.4), content reflow at high zoom levels (1.4.10), adjustable text spacing properties (1.4.12), and touch target dimensions sufficient for users with reduced visual acuity (2.5.5).

The fourth dimension captures the user experience and emotional dimension of mobile banking interaction, encompassing the affective responses users experience during banking task execution, perceptions of trust and security within the digital environment, the degree of transactional independence achieved, and overall satisfaction with the mobile banking experience as a whole.

### **2.7.1 Research Variables**

Informed by the conceptual framework described above, this study identifies the following research variables. The independent variables consist of WCAG 2.1 Level A and AA success criteria compliance, screen reader compatibility as evaluated through TalkBack on Android, and visual design attributes including color contrast ratios, typography, spatial spacing, and interactive element target dimensions. The dependent variables comprise task completion rate reflecting the user's ability to independently execute core banking functions, interaction efficiency measured through task completion time and the number of navigation steps required, and user satisfaction as quantified through System Usability Scale scores and qualitative feedback gathered via think-aloud protocol and semi-structured interviews.

### **2.7.2 Evaluation Approach**

The study employs an integrated mixed-methods evaluation approach encompassing two complementary strands. The quantitative strand involves a systematic feature-by-feature inspection of the BRImo application using manual TalkBack screen reader navigation, assessing compliance with WCAG 2.1 Level A and AA success criteria, and documenting specific violations with reference to the relevant criterion. The qualitative strand involves participatory usability testing with visually impaired participants encompassing both totally blind and low-vision users executing fundamental banking tasks within the live BRImo application, with concurrent data collection through the think-aloud protocol, structured observation, and semi-structured interviews. This integrated approach directly addresses the

methodological shortcomings identified in prior research, which has demonstrated that automated testing alone is insufficient to capture the full range of accessibility barriers encountered by screen reader users in real-world interaction contexts (Lopes et al., 2022; Masruroh et al., 2022).

### 2.7.3 Conceptual Framework Diagram

The conceptual framework of this research is visually summarized in Figure 2.1, which illustrates the logical relationships among the key components of the study. The diagram organizes the research into four interconnected levels: independent variables, user population, dependent variables, and research outcomes. The independent variables consist of three main categories: WCAG 2.1 Level A/AA compliance (covering the POUR principles), screen reader compatibility (specifically TalkBack on Android), and visual design, including Color Contrast Analysis (CCA) for low-vision users. These variables directly influence the experience of the visually impaired user population, which is divided into blind users (who rely entirely on the screen readers) and low-vision users (who depend on adequate contrast, text resizing, and spacing). The effects are captured through the dependent variables: effectiveness (task completion and error rates), efficiency (time per task and number of interactions), and satisfaction (System Usability Scale scores and qualitative feedback). Finally, the framework leads to tangible outcomes such as a WCAG compliance report, a detailed CCA report, identified accessibility violations, and evidence-based recommendations for improving BRImo's accessibility. Thus, Figure 2.1 provides a clear roadmap for the evaluation methodology and data analysis in this research.

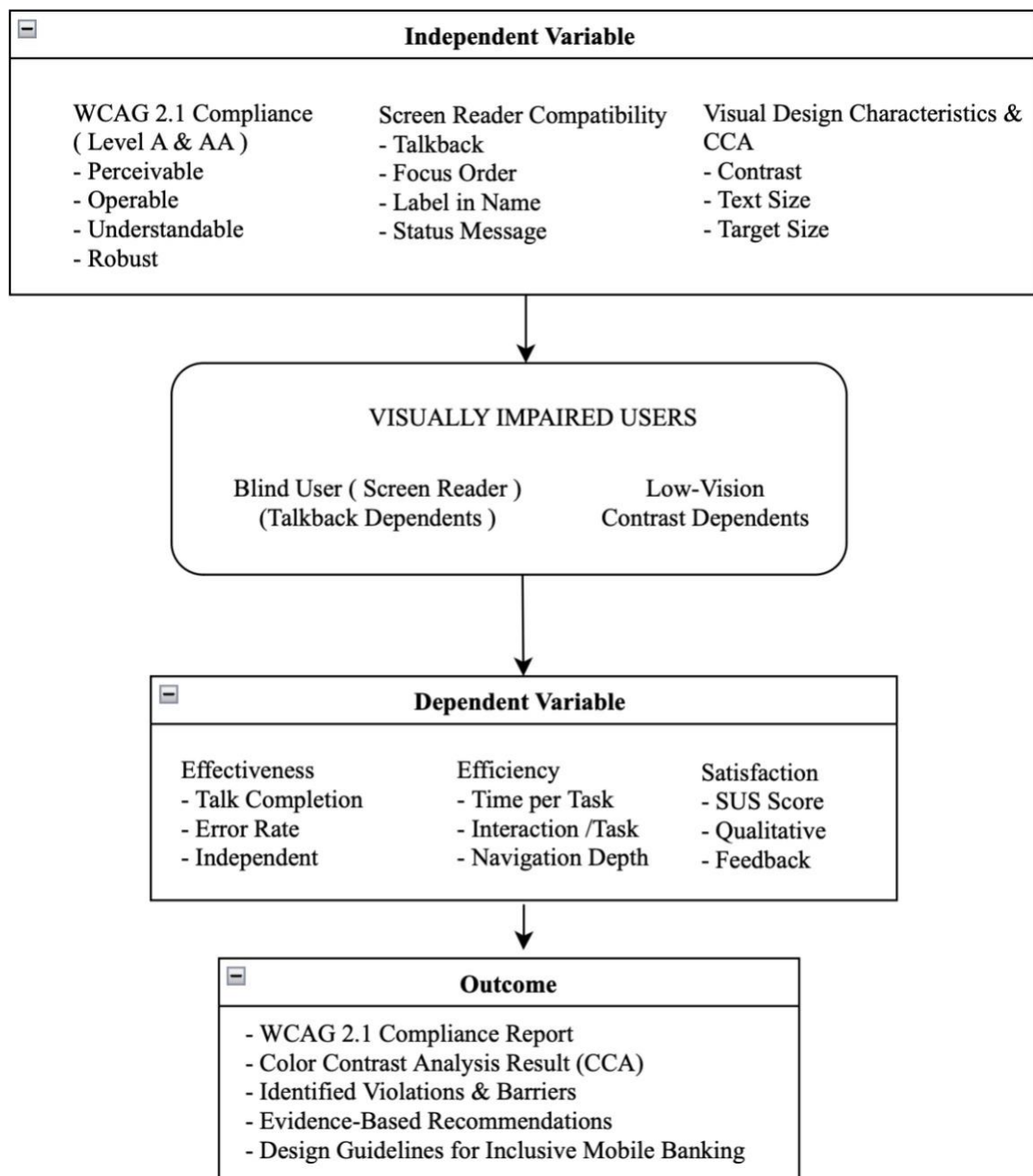


Figure 2.1 Conceptual framework diagram

## CHAPTER III

### RESEARCH METHODOLOGY

#### 3.1 Research Approach and Type

This research adopts a qualitatively dominant mixed-methods approach, integrating qualitative and quantitative data collection and analysis methods within a single sequential research design. The qualitative strand constitutes the primary mode of inquiry, encompassing systematic TalkBack accessibility inspection, participatory usability testing with the concurrent think-aloud protocol, and semi-structured interviews. These methods are oriented toward generating a contextually rich, in-depth understanding of the accessibility barriers encountered by this user group during real-world mobile banking interactions. The quantitative strand provides a complementary layer of standardized measurement, comprising WCAG 2.1 compliance mapping using a four-level conformance scale: Supports, Does not Support, Supports with Exceptions, and Not Applicable per success criterion, System Usability Scale scoring, task completion rate documentation, and SUS analysis for the testing phase.

The adoption of a mixed-methods design is directly warranted by the nature of the research objectives: evaluating mobile banking accessibility for these users requires both the normative precision of standards-based compliance measurement and the interpretive depth of lived user experience. Neither approach alone would be sufficient, as purely quantitative compliance assessment cannot reveal how barriers manifest in real interaction contexts, while purely qualitative description cannot produce the structured, criterion-referenced evidence base required for actionable remediation recommendations. The integration of both strands through methodological triangulation therefore produces findings that are simultaneously rigorous, contextually grounded, and practically applicable (Creswell & Clark, 2017).

Usability testing is employed as the principal data collection method because it allows the researcher to directly observe participants performing realistic banking tasks, capture real-time difficulties, and gather verbal accounts of user experiences through the think-aloud protocol. This aligns with the recommendation of (Lopes et al., 2022) that automated testing must be complemented by manual inspection and user testing to fully capture the lived accessibility experience of individuals with disabilities.

The evaluation framework is grounded in two established theoretical bases: Nielsen's (2012) five-dimensional usability model encompassing learnability, efficiency, memorability, error management, and satisfaction, and the WCAG 2.1 POUR principles (Perceivable,

Operable, Understandable, and Robust), which provide the normative criteria against which all accessibility observations are benchmarked.

### 3.2 Variables and Operational Definitions

This study identifies and operationalizes five key variables that collectively capture the accessibility, usability, and user experience dimensions evaluated across the research phases. Table 3.1 presents the operational definition and measurement indicator for each variable.

Table 3.1 Operational definitions of research variables

| Variable                    | Operational Definition                                                                                                                                                      | Measurement Indicator                                                                                               |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| Usability                   | The degree to which visually impaired users can complete BRImo banking tasks effectively, efficiently, and with satisfaction using TalkBack.                                | Task completion rate, number of errors, task duration, SUS score                                                    |
| Accessibility               | The extent to which BRImo's interface conforms to WCAG 2.1 Level AA success criteria as navigated via TalkBack screen reader on Android.                                    | WCAG 2.1 conformance level (Supports / Supports with Exceptions / Not Applicable) per success criterion per feature |
| User Experience (UX)        | The overall quality of interaction experienced by visually impaired users during banking task completion, including emotional and cognitive dimensions (ISO 9241-210:2018). | Think-aloud observations, post-task interview responses, SUS score                                                  |
| Visual Usability            | The degree to which visual design elements (color contrast, text size, layout spacing, target size) in the BRImo prototype support independent use by low-vision users.     | WCAG 2.1 criteria 1.4.3, 1.4.4, 1.4.10, 1.4.11, 1.4.12, 2.5.3 compliance; participant feedback in User Testing B    |
| Screen Reader Compatibility | The ability of TalkBack to accurately announce, sequence, and interact with BRImo's interface elements during banking task navigation.                                      | Correctness and completeness of TalkBack announcements per interface element                                        |

### 3.3 Population and Sample

#### 3.3.1 Population

The target population of this study consists of visually impaired individuals in Indonesia who have prior experience using mobile banking applications. This population is selected based on the research objective of evaluating real-world accessibility barriers encountered by the target population in digital financial services. According to Rif'Ati et al. (2021), approximately

8.02 million Indonesians are estimated to have visual impairments, of whom a significant proportion are of working age and could benefit from independent access to mobile banking. Of this population, only 24.3% are currently reported to hold bank accounts, underscoring the critical relevance of accessibility research for this demographic.

### **3.3.2 Sampling Technique**

This research employs purposive sampling, a non-probability sampling technique in which participants are selected based on specific, predefined criteria relevant to the research objectives (Etikan et al., 2016). Purposive sampling is considered most appropriate for usability research because the goal is not statistical generalization but rather the in-depth examination of experiences within a specific user group, in this case, mobile banking users with visual impairments.

This sampling decision is further justified by Nielsen's (2000) seminal finding that usability testing with as few as five participants is sufficient to identify approximately 85% of usability problems within a homogeneous user group. For studies involving specialized user populations such as individuals with disabilities, a targeted purposive sample of six to ten participants is widely accepted as methodologically appropriate (Tongco, 2006).

The age range of 19 to 30 years is applied as an inclusion criterion for both User Testing A and User Testing B on three grounds. First, this demographic constitutes the primary user base of mobile banking applications in Indonesia, as digital banking adoption is concentrated among younger adults who represent the most frequent users of smartphone-based financial services (Fadli et al., 2024). Second, participants within this range are more likely to possess prior experience with both mobile banking applications and TalkBack screen reader technology, ensuring that observed difficulties reflect genuine accessibility barriers rather than general unfamiliarity with digital interfaces. Third, restricting the age range reduces age-related confounding variables, such as declining digital literacy or motor control challenges associated with older age that could introduce extraneous sources of variability into the evaluation findings.

### **3.3.3 User Testing A (Participants)**

User Testing A involves six participants with visual impairments, recruited to evaluate the current BRImo application using TalkBack on their own Android devices. The group composition, four totally blind participants and two with low vision is determined by three

converging considerations. First, the primary evaluation instrument of this study is TalkBack screen reader interaction, which constitutes the dominant and most critical assistive technology modality for totally blind users. Recruiting four totally blind participants ensures sufficient representation of the user group for whom TalkBack is the exclusive mode of mobile interface interaction, thereby prioritizing the evaluation of the most severe and consequential accessibility barriers encountered in the live BRIImo application. Second, the inclusion of two low-vision participants serves a complementary purpose: low-vision users interact with mobile interfaces through a combination of residual visual perception and assistive features such as text enlargement and high-contrast display modes, meaning their experience surfaces a distinct but equally important category of accessibility barrier particularly in the dimensions of color contrast, text scaling, and visual layout that would not be captured by blind participants alone. Third, the 4:2 composition reflects a deliberate methodological weighting consistent with the study's primary focus on TalkBack screen reader accessibility, while ensuring that the low-vision dimension of visual impairment is represented within the evaluation. It is further noted that participants in User Testing A employed varying assistive technology configurations during testing, some relying exclusively on TalkBack, others using non-TalkBack visual interaction, and others employing a combination of both, reflecting the naturalistic diversity of assistive technology usage patterns among mobile banking users with visual impairments in Indonesia. All participants use Android smartphones as their primary device, ensuring ecological validity in the testing scenario. Table 3.2 presents the inclusion and exclusion criteria used to determine participant eligibility for User Testing A.

Table 3.2 Inclusion and exclusion criteria for user testing A

| Criteria                  | Inclusion                                                                                       | Exclusion                                        |
|---------------------------|-------------------------------------------------------------------------------------------------|--------------------------------------------------|
| Visual Status             | Totally blind or low vision (as self-reported and confirmed through organizational affiliation) | Individuals with full sighted vision             |
| Device                    | Android smartphone user with TalkBack enabled as primary navigation tool                        | iOS-only users or users unfamiliar with TalkBack |
| Mobile Banking Experience | Has prior experience using at least one mobile banking application                              | No prior mobile banking experience               |
| Banking                   | Possesses an active BRI account and the BRIImo application installed on their personal device   | Does not have an active BRI account              |

| Criteria | Inclusion                               | Exclusion                                 |
|----------|-----------------------------------------|-------------------------------------------|
| Age      | 19–30 years old                         | Below 19 or above 30 years old            |
| Language | Able to communicate in Bahasa Indonesia | Unable to communicate in Bahasa Indonesia |

Participants for User Testing A were recruited through direct coordination with five disability organizations and institutions in the Yogyakarta region and beyond: Ikatan Tunanetra Muslim Indonesia (ITMI), Braille’iant Indonesia, Lembaga Sosial Tunanetra Al-Hikmah DIY, Yayasan Kesejahteraan Tuna Netra Islam (YAKETUNIS), and Persatuan Tunanetra Indonesia Daerah Istimewa Yogyakarta (Pertuni DIY). These organizations provided access to established communities of individuals in this group with documented mobile technology experience, thereby ensuring the recruitment of participants who met all inclusion criteria.

### 3.4 Pilot Study

Before the commencement of formal data collection, an exploratory preliminary study was conducted between October and December 2025. The pilot study was not designed to produce primary research findings but rather to fulfill three instrumental functions: confirming the feasibility of the planned evaluation approach, identifying the most appropriate target application for the formal evaluation, and refining the research instruments before their deployment in the formal data collection phases. The pilot study involved 15 individuals in this group recruited from the same disability organization networks, utilizing a combination of Google Form questionnaires and direct in-person engagement.

The pilot study was exploratory in nature and focused on three preliminary research questions: (a) whether individuals in this group use mobile banking applications; (b) which mobile banking applications they use most frequently; and (c) what general difficulties, if any, they encounter when performing mobile banking tasks. This preliminary data confirmed that all 15 pilot participants had prior mobile banking experience, validating the feasibility of the planned usability testing approach. The pilot study also informed the selection of BRI<sub>mo</sub> as the target application, given its widespread use among participants, and confirmed the relevance of the seven core features selected for evaluation.

Importantly, the pilot study served as the basis for the researcher’s initial TalkBack accessibility inspection of the BRI<sub>mo</sub> application, which preceded the formal instrument development. Findings from this inspection, combined with pilot study observations, were

reviewed by the research advisor, Chanifah Ratnasari Indah, who provided formative feedback on the evaluation matrix, task scenarios, and interview guide before their finalization. Instrument revisions were made in accordance with this feedback before the commencement of User Testing A.

### **3.5 Data Collection Methods**

This research employs four complementary data collection methods to ensure comprehensive coverage of both objective accessibility compliance and subjective user experience. The integration of these methods constitutes a methodological triangulation approach, strengthening the credibility and validity of the findings.

#### **3.5.1 Systematic TalkBack Accessibility Inspection**

Before the commencement of user testing phases, the researcher conducted a systematic manual accessibility inspection of the BRImo application across all seven core features, employing four complementary evaluation instruments: TalkBack screen reader navigation on an Android device, Google Accessibility Scanner automated report generation, Color Contrast Analyzer (CCA) ratio measurement, and WCAG 2.1 compliance assessment using the Harvard University Vendor Checklist. Each instrument targets a distinct dimension of accessibility compliance, and their combined application ensures multi-dimensional coverage of both technical and perceptual accessibility barriers. The full procedure for this inspection phase is described in Stage 2 of the Research Procedure section. This inspection methodology is consistent with approaches employed in prior accessibility research (Alayed, 2024; Lopes et al., 2022) and provides a systematic, feature-by-feature baseline of accessibility compliance before user testing.

#### **3.5.2 Usability Testing with Think-Aloud Protocol**

Usability testing constitutes the primary data collection method for the User Testing A. Participants are requested to complete a series of pre-defined banking tasks, and the researcher observes and records their interactions, noting task completion status, errors, navigational difficulties, and time taken. Each testing session lasts approximately 45 to 60 minutes per participant.

The concurrent think-aloud protocol is employed throughout all testing sessions, wherein participants are instructed to verbalize their thoughts, intentions, and reactions as they interact

with the application in real time. This protocol provides direct insight into the cognitive processes, confusion points, and accessibility barriers experienced by participants during task completion, and is particularly valuable for capturing the qualitative dimensions of the user experience that cannot be observed through behavioral data alone (Soure et al., 2021).

For User Testing A sessions were conducted in person, the researcher was physically present and directly observed the participant's interaction with their own Android device. For the two User Testing A sessions conducted remotely via Zoom on 7 April 2026, participants used a separate device to join the Zoom call and verbalized their experience through the think-aloud protocol; the researcher relied on verbal narration and audio observation, given that screen sharing was not utilized in these sessions.

### **3.5.3 Semi-Structured Interview**

Following the completion of all tasks in each session, a semi-structured interview was conducted with each participant. The interview guide, developed and validated by the research advisor before data collection, covers three thematic areas: (a) the participant's general experience using mobile banking applications as a visually impaired user; (b) specific difficulties encountered during the testing session; and (c) suggestions for improvement. The semi-structured format allows for standardized coverage of key topics while permitting the researcher to probe emerging themes and follow up on participant responses, thereby capturing rich qualitative data relevant to the research questions.

### **3.5.4 System Usability Scale (SUS) Questionnaire**

The System Usability Scale (SUS), originally developed by Brooke (1996), is administered to all participants at the conclusion of each testing session. The SUS is a widely validated, ten-item Likert scale instrument that provides a standardized, quantitative measure of perceived usability. Scores range from 0 to 100, with scores above 70 generally classified as acceptable and scores above 85 considered excellent (Peres et al., 2013). The SUS questionnaire was translated into Bahasa Indonesia and administered verbally by the researcher to ensure accessibility for participants who may have difficulty reading printed or on-screen text. The SUS is used in this study to complement qualitative observations with a standardized usability benchmark.

### 3.6 Research Instruments

Four primary research instruments are employed in this study. Each is designed to capture a distinct dimension of the accessibility and usability evaluation.

#### 3.6.1 Task Scenarios

Task scenarios are constructed for the seven core BRImo features identified in the scope of the study. Each scenario presents a realistic banking context that motivates the participant to complete a specific action without prescribing the steps to be taken, thereby preserving the authenticity of the user interaction. The seven task scenarios are presented in Table 3.3.

Table 3.3 Usability testing task scenarios

| No. | Feature                                               | Task Description                                                                                                                              |
|-----|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Login (BRI Login)                                     | You want to log in to your BRImo account. Please open the application and complete the login process.                                         |
| 2   | Account Balance Check (BRI Cek Saldo)                 | You want to check the current balance of your BRI savings account. Please navigate to the relevant feature and retrieve your account balance. |
| 3   | Domestic Fund Transfer (BRI Transfer)                 | You want to transfer IDR 50,000 to a fellow BRI account holder. Please complete the fund transfer process.                                    |
| 4   | QRIS Payment (BRI Q-RIS)                              | You want to make a payment using QRIS. Please navigate to the QRIS feature and initiate the payment process.                                  |
| 5   | Transaction History (BRI Riwayat Transaksi)           | You want to review your five most recent BRImo transactions. Please navigate to the transaction history feature and locate this information.  |
| 6   | Mobile Credit & Data Top-up (BRI Top-up > Pulsa/Data) | You want to purchase mobile data for your phone number. Please navigate to the top-up feature and complete the process.                       |
| 7   | E-Wallet Top-up (BRI Top-up > E-Wallet)               | You want to top up your GoPay e-wallet. Please navigate to the e-wallet top-up feature and complete the process.                              |

#### 3.6.2 Evaluation Matrix

An evaluation matrix is employed by the researcher during all usability testing sessions to systematically record observational data for each task and participant. The matrix captures four dimensions of usability performance, consistent with ISO 9241-11:2018 and Nielsen's (2012) framework are presented in Table 3.4.

Table 3.4 Evaluation matrix dimensions

| Dimension     | Definition                               | Observation Indicator                                                         |
|---------------|------------------------------------------|-------------------------------------------------------------------------------|
| Effectiveness | The accuracy and completeness with which | Task completed successfully (Yes/No/Partial); nature of failure if incomplete |

|              |                                                                                                 |                                                                                                          |
|--------------|-------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
|              | participants achieve the specified task goal.                                                   |                                                                                                          |
| Efficiency   | The resources expended in relation to the accuracy and completeness of task completion.         | Estimated time taken; number of navigational steps or interactions required                              |
| Errors       | The number and nature of mistakes made by participants during task completion.                  | Type of error (navigation error, misidentification, incorrect action); frequency; whether self-corrected |
| Observations | Qualitative notes on participant behavior, TalkBack announcements, and verbalized difficulties. | Researcher's field notes; participant think-aloud statements; notable TalkBack output                    |

The evaluation matrix is completed by the researcher in real time during each usability testing session, with observational notes recorded contemporaneously as participants perform each task. This contemporaneous completion approach minimizes recall bias and ensures that the TalkBack announcement details. Those that are transient and may not be reproducible after the session are captured with accuracy at the moment of occurrence. For each task, the researcher records the effectiveness outcome (completed, partially completed, or not completed), estimates the time taken and number of navigational steps required for efficiency measurement, documents the type and frequency of errors observed, and notes significant TalkBack announcements and participant think-aloud statements as qualitative observations. The completed matrices serve as the primary source of evidence for the WCAG 2.1 conformance assessment and qualitative descriptive analysis conducted in the post-testing phase, as described in the Data Analysis Techniques section.

### 3.6.3 SUS Questionnaire (Bahasa Indonesia)

The ten-item SUS questionnaire is administered verbally by the researcher in Bahasa Indonesia at the conclusion of each session. Each item is rated on a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The scoring procedure and analytical treatment of SUS results are detailed in the Data Analysis Techniques section. This instrument is administered to participants in User Testing A, with scores analyzed separately within their respective evaluation contexts.

The four research instruments serve distinct and complementary roles within the evaluation framework. The systematic TalkBack accessibility inspection and WCAG 2.1 conformance assessment measure objective accessibility compliance. Identifying specific barriers and their correspondence to established standards. The SUS questionnaire measures

perceived usability, participants' subjective impression of ease of use, rather than accessibility compliance directly. A system may record a favorable SUS score while exhibiting critical accessibility barriers, particularly when participants employ compensatory strategies developed through prior application familiarity. The think-aloud protocol and semi-structured interview provide the contextual layer, explaining how and why barriers affect the interaction experience in ways that compliance mapping and SUS scores alone cannot capture.

#### **3.6.4 Semi-Structured Interview Guide**

The interview guide consists of three thematic question clusters. The first cluster addresses general mobile banking usage patterns and the participants' prior experience as mobile banking users with visual impairments. The second cluster focuses on the specific difficulties and accessibility barriers encountered during the usability testing session. The third cluster solicits participant suggestions and preferences regarding ideal accessibility improvements for mobile banking applications. The interview guide was reviewed and validated by the research advisor, Chanifah Indah Ratnasari, before pilot deployment, and minor revisions were incorporated based on the advisor's feedback.

### **3.7 Validity and Reliability**

#### **3.7.1 Content Validity**

Content validity in this research is primarily established through the theoretical and normative grounding of all instruments in internationally recognized frameworks. The evaluation matrix is structured around the four dimensions of ISO 9241-11:2018: effectiveness, efficiency, errors, and satisfaction. Ensuring that observational categories directly correspond to established usability measurement standards. The WCAG 2.1 conformance assessment derives its validity from the normative authority of the W3C Web Content Accessibility Guidelines, which constitute the internationally recognized standard for digital accessibility evaluation. The task scenarios are grounded in the seven core BRImo features selected through a convergence of three evidence sources: pilot study findings confirming these features as the most frequently used by visually impaired mobile banking users, a review of prior accessibility research identifying fund transfer, balance checking, and payment features as the most accessibility-critical functions in mobile banking contexts (Alayed, 2024; Lopes et al., 2022), and BRImo's own feature architecture which positions these seven functions as the primary transactional capabilities available to all users regardless of account type. The SUS

questionnaire's content validity is established through its extensive validation across decades of usability research, with a reported Cronbach's alpha of 0.91 confirming strong internal consistency (Bangor et al., 2009). Advisor review by Chanifah Indah Ratnasari serves as an additional contextual validation layer, confirming the appropriateness of instrument language and task design for the Indonesian research setting, with revisions incorporated before formal deployment.

### **3.7.2 Reliability of the SUS**

The System Usability Scale is a widely validated and internally consistent instrument with a reported Cronbach's alpha of 0.91, confirming high reliability (Karakaya & Alparslan, 2019). The SUS has been used extensively in mobile application usability research, including studies involving assistive technology users, and is considered a gold-standard instrument for standardized usability measurement. Its reliability in the context of this research is further supported by the use of a consistent Bahasa Indonesia translation administered verbally by the researcher to all participants under standardized conditions.

### **3.7.3 Triangulation**

To strengthen the overall credibility and trustworthiness of the research findings, methodological triangulation is employed through the convergence of four data sources: (a) systematic TalkBack accessibility inspection findings cross-referenced with WCAG 2.1 conformance assessment criteria; (b) usability testing observations recorded in the evaluation matrix; (c) qualitative data from the semi-structured interviews; and (d) quantitative SUS scores. Convergence across these data sources increases confidence in the identified accessibility barriers, while divergence provides opportunities for deeper analytical inquiry. This triangulation approach is consistent with best practice guidelines for qualitative usability research involving users with disabilities.

### 3.8 Research Procedure

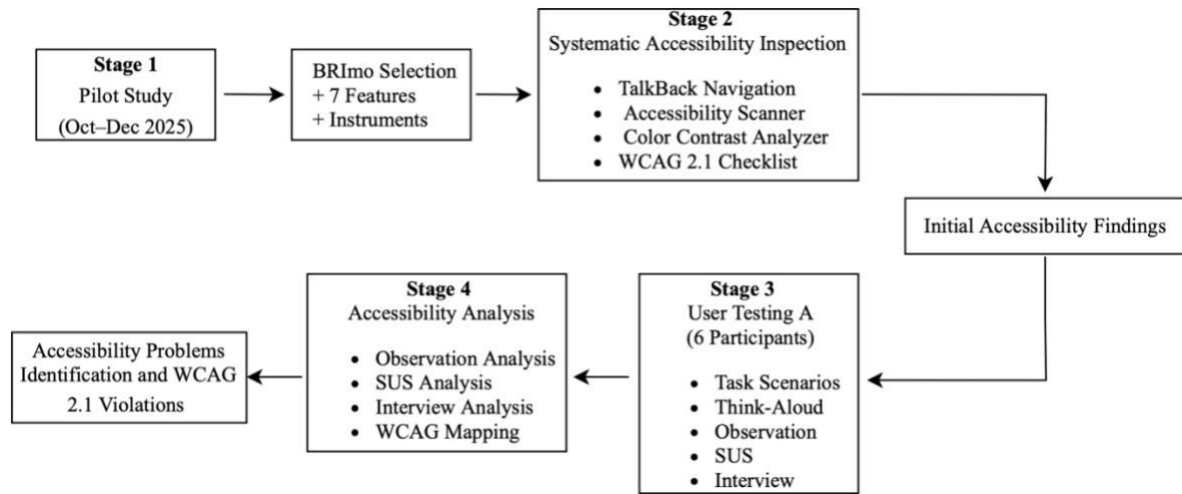


Figure 3.2 Research Procedure Diagram

Figure 3.1 Overview of the four-stage research procedure. The research is conducted in four sequential stages as illustrated in the following procedural overview:

#### 3.8.1 Stage 1: Pilot Study (October – December 2025)

The pilot study conducted between October and December 2025 is described in full in the Pilot Study section above. Its findings informed the selection of BRImo as the evaluation target, confirmed the seven core features for formal evaluation, and provided the empirical basis for research instrument development and subsequent advisor validation before the commencement of User Testing A.

#### 3.8.2 Stage 2: Systematic TalkBack Accessibility Inspection

Before the commencement of User Testing A, the researcher conducted a comprehensive systematic TalkBack accessibility inspection of the BRImo application across all seven core features selected for evaluation. This inspection was conducted exclusively by the researcher and employed four complementary evaluation instruments to ensure multi-dimensional coverage of accessibility compliance.

The first instrument was TalkBack screen reader navigation, conducted on the researcher's Android device with TalkBack enabled. The researcher navigated each of the seven features sequentially by swiping right in TalkBack exploration mode, activating each interactive element through double-tap, and systematically recording TalkBack's announcement for every

interface element encountered. This process produced a complete TalkBack interaction flow for each feature, documenting the screen reader's behavior, including element labels announced, reading order, gesture responsiveness, and any unintelligible or absent announcements as the basis for screen reader compatibility assessment.

The second instrument was the Google Accessibility Scanner, an automated accessibility evaluation tool developed by Google that analyzes the visual and structural properties of Android application screens. The scanner was run across all seven features of BRImo, generating automated reports identifying potential accessibility violations, including insufficient touch target sizes, missing content labels, low color contrast, and unspokeable items. The Accessibility Scanner findings complemented the manual TalkBack inspection by providing a systematic automated baseline of interface-level accessibility issues.

The third instrument was the Color Contrast Analyzer (CCA). Each color pair was sampled directly from the BRImo interface screenshots using the CCA eyedropper tool, and the resulting contrast ratio was compared against the WCAG 2.1 Level AA. All contrast ratio measurements were documented and are reported in Chapter IV.

The fourth instrument was the WCAG 2.1 Vendor Checklist, adapted from the Harvard University WCAG 2.1 Accessibility Conformance Reporting Template. This checklist provided a structured, criterion-by-criterion framework for evaluating BRImo's conformance with each applicable WCAG 2.1 Level A and Level AA success criterion. For each criterion, the researcher assigned one of four conformance levels: Supports, Does not support, Supports with Exceptions, or Not Applicable based on the combined evidence gathered through TalkBack navigation, Accessibility Scanner findings, and CCA measurements. This checklist constitutes the primary WCAG 2.1 compliance mapping instrument for the study and forms the normative evaluative backbone of Chapter IV.

The four instruments were applied in the following sequence for each of the seven features: (1) TalkBack navigation and flow documentation; (2) Google Accessibility Scanner automated report generation; (3) CCA color contrast measurement from feature screenshots; and (4) WCAG 2.1 checklist completion based on all gathered evidence. Findings from this inspection phase were cross-referenced with User Testing A observations in Stage 3 to produce the final consolidated accessibility evaluation reported in Chapter IV.

### 3.8.3 Stage 3: User Testing A (Sessions 3a and 3b)

User Testing A was conducted in two sub-sessions. The first sub-session took place on 14 February 2026 and involved four participants in an in-person setting. The second sub-session was conducted on 7 April 2026 with two participants via Zoom video conferencing, as these participants were not located within the researcher's immediate area. In the Zoom sessions, participants used a separate device to join the call while using their own Android smartphone to interact with BRImo; the researcher observed through verbal think-aloud narration provided by the participants.

Each session followed a standardized protocol: (a) introduction and informed consent; (b) briefing on the think-aloud protocol; (c) administration of the seven task scenarios in sequence; (d) observation and recording using the evaluation matrix; (e) SUS questionnaire administration in Bahasa Indonesia; and (f) semi-structured interview. Each session lasted approximately 45 to 60 minutes. Participants used their own Android smartphones with TalkBack enabled and their own active BRI accounts, ensuring ecological validity.

### 3.8.4 Stage 4: Accessibility Analysis and Problem Mapping

Following User Testing A, all observational data, evaluation matrices, think-aloud records, interview notes, and SUS scores were systematically analyzed. Accessibility problems were categorized and mapped against the WCAG 2.1 Level AA success criteria to identify specific compliance violations. Each identified problem was documented in terms of its affected WCAG principle (Perceivable, Operable, Understandable, or Robust), the specific success criterion violated, the feature in which it occurred, and its observed impact on task completion.

Table 3.5 summarizes the complete research procedure across all six stages. Including the timeline, participants involved, and mode of implementation for each activity conducted in this study.

Table 3.5 Summary of research procedure and timeline

| Stage | Activity                                     | Period                  | Participants                        | Mode                                |
|-------|----------------------------------------------|-------------------------|-------------------------------------|-------------------------------------|
| 1     | Pilot Study                                  | October – December 2025 | 15 visually impaired individuals    | Google Form + In-person             |
| 2     | Systematic TalkBack Accessibility Inspection | December – January 2026 | Researcher only                     | Manual inspection on Android device |
| 3a    | User Testing A – Session 1                   | 14 February 2026        | 4 participants (blind & low vision) | In-person                           |

|    |                            |                       |                                     |               |
|----|----------------------------|-----------------------|-------------------------------------|---------------|
| 3b | User Testing A – Session 2 | 7 April 2026          | 2 participants (blind & low vision) | Zoom (remote) |
| 4  | Analysis & Problem Mapping | February – March 2026 | —                                   | Desk analysis |

As illustrated in Table 3.5, the research procedure spans from October 2025 to March 2026, progressing sequentially from the pilot study through systematic accessibility inspection, participatory user testing, and an intervening analysis. The sequential nature of the result ensures that findings from each stage directly inform the subsequent stage, with pilot study insights shaping instrument development, inspection findings establishing the accessibility baseline and User Testing A.

### 3.9 Data Analysis Techniques

#### 3.9.1 Qualitative Descriptive Analysis

All qualitative data comprising observational field notes from the evaluation matrix, think-aloud transcripts, and semi-structured interview responses are analyzed using qualitative descriptive analysis. This approach involves systematic identification, categorization, and description of accessibility barriers and usability issues reported by participants. Data are organized thematically according to the seven BRImo features evaluated and the four WCAG 2.1 POUR principles, enabling structured comparison across features and participants. Recurring patterns of difficulty are highlighted as primary findings, and their implications for visually impaired users' ability to independently conduct banking transactions are discussed.

#### 3.9.2 WCAG 2.1 Compliance Mapping

Each accessibility barrier identified through the TalkBack inspection and User Testing A is systematically mapped to the specific WCAG 2.1 Level AA success criterion it violates. Conformance is assessed using a four-level scale adapted from the Harvard University WCAG 2.1 Vendor Checklist: Supports, indicating full compliance with no observed issues; Does not support, indicating the criterion observed issues for all the elements; Supports with Exceptions, indicating partial compliance where some elements meet the criterion while others do not; and Not Applicable, indicating that the criterion does not apply to the evaluated features of BRImo. This four-level scale provides a more nuanced and accurate representation of accessibility compliance than a binary pass/fail classification, reflecting the reality that many accessibility issues in mobile applications manifest as partial rather than complete failures.

This mapping is documented in an accessibility evaluation matrix recording the feature in which each barrier occurs, the WCAG principle and success criterion violated, the TalkBack behavior or visual design issue observed, the severity of its impact on task completion, and the proposed remediation incorporated into the Figma prototype redesign. This structured compliance mapping enables the research to move beyond subjective usability description toward normative, evidence-based assessment grounded in an internationally recognized accessibility standard.

### 3.10 Research Tools and Equipment

Table 3.6 lists the tools and equipment employed across all research phases. Specifying the function of each instrument within the study's data collection and analysis activities.

Table 3.6 Research tools and their functions

| Tool / Equipment                                   | Function in This Research                                                                                                                                                       |
|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Android Smartphones<br>(Participants' own devices) | Used by all six User Testing A participants to interact with the live BRIimo application on their own personal devices with active BRI accounts, ensuring ecological validity   |
| TalkBack (Android built-in screen reader)          | Primary assistive technology employed by User Testing A participants for BRIimo navigation, and used by the researcher during the preliminary TalkBack accessibility inspection |
| Zoom Video Conferencing                            | Used to conduct two remote User Testing A sessions with participants not located within the researcher's immediate area on 7 April 2026                                         |
| Google Forms                                       | Used during the pilot study to collect preliminary data on mobile banking usage and accessibility experiences from 15 visually impaired participants                            |

### 3.11 Limitations of the Research

This research acknowledges several methodological limitations that should be considered when interpreting its findings:

#### a. Sample Size and Generalizability

The study involves eleven participants in total, six in User Testing A. All aged 19 to 30 years and recruited from disability organizations in or affiliated with the Yogyakarta region. This sample size is appropriate for the qualitative and accessibility-focused objectives of this research, consistent with Nielsen's (2000) guideline of five participants for usability studies and purposive sampling norms for specialized user populations. As with all small purposive

samples, findings are most appropriately interpreted as indicative of key accessibility patterns rather than statistically representative of the full diversity of Indonesia's visually impaired population across age, geographic location, device familiarity, and educational background.

b. Zoom Session Observation Constraints

For these two sessions, the researcher relied on participants' concurrent think-aloud narration as the primary observational data source, as direct screen observation was not feasible in the remote format. This approach is consistent with established remote usability testing methodology and is acknowledged as a contextual constraint that may have yielded less granular observational data compared to in-person sessions, where direct screen observation and researcher-initiated probing are possible.

c. Scope Restricted to Selected Features

The evaluation is confined to seven core features of the BRImo application as defined in the scope of the study. BRImo offers a considerably broader range of features and services that are not examined in this research. Additionally, the evaluation focuses on the BRImo version available at the time of testing, and findings may not be fully applicable to subsequent versions of the application that incorporate interface updates or accessibility improvements.

## **CHAPTER IV**

### **RESULTS AND DISCUSSION**

#### **4.1 Introduction**

This chapter presents a comprehensive, multi-instrument accessibility evaluation of the BRImo mobile banking application for visually impaired users. The evaluation is structured to build progressively toward a complete understanding of BRImo's accessibility status. The chapter begins with a pilot survey that establishes the real-world context of visually impaired users' mobile banking needs and experiences, providing the empirical basis for the selection of BRImo and its seven core features as the evaluation focus. This is followed by automated accessibility scanning using the Google Accessibility Scanner, which identifies technical violations at the interface level. A manual TalkBack screen reader inspection then captures the authentic screen reader experience that automated tools cannot replicate. WCAG 2.1 conformance assessment maps all identified barriers against the internationally recognized accessibility standard, providing a normative framework for interpreting findings. Color contrast analysis using the Color Contrast Analyzer addresses the specific visual design barriers most consequential for low-vision users. Finally, User Testing A with six visually impaired participants validates and extends all inspection findings through real-world interaction observation. The chapter concludes with a synthesis discussion that integrates findings across all instruments to identify the most critical accessibility patterns.

Each identified barrier, from unlabeled icon-only buttons and unintelligible QRIS navigation to low color contrast and undersized touch targets, is systematically addressed in the redesign. The redesigned prototype incorporates WCAG 2.1-aligned improvements, including descriptive TalkBack labels, semantic content structure, scalable typography, enlarged touch targets, and contrast-compliant color schemes.

#### **4.2 Pilot Survey Results**

A preliminary pilot survey was conducted with 15 visually impaired respondents (9 totally blind, 6 low vision) to ensure that the formal accessibility evaluation would be grounded in real-world user experiences. The survey had two main purposes: first, to identify which mobile banking applications and features are most relevant to visually impaired users in Indonesia; second, to gather initial evidence of accessibility barriers that would inform the task scenarios and analytical focus of the main study.

Among the 15 respondents, 11 (73.3%) actively use mobile banking applications. Table 4.1 below shows the distribution of mobile banking applications used by these respondents. BRImo was the most frequently used application, reported by 4 users, followed by Beyond by BSI (3 users) and BSI Mobile (2 users). This finding, while based on a small pilot sample and not statistically generalizable to the entire visually impaired population of Indonesia, justifies the selection of BRImo as the primary evaluation target for this study. Among the pilot respondents, BRImo was the most frequently used application, indicating that it is a relevant and accessible platform for in-depth accessibility evaluation

Table 4.1 Distribution of mobile banking users

| Mobile Banking Application | Number of Users |
|----------------------------|-----------------|
| BRImo                      | 4               |
| Beyond by BSI              | 3               |
| BSI Mobile                 | 2               |
| Livin' by Mandiri          | 2               |
| BCA Mobile                 | 1               |
| Muamaladdin                | 1               |
| Bank Jateng                | 1               |

Respondents reported a range of accessibility barriers across different applications. BRImo users specifically noted login-related difficulties where certain interface elements were not reliably announced by TalkBack. Users of Livin' by Mandiri reported a more severe failure: the inability to complete facial and eye verification, which caused several respondents to discontinue use entirely. These findings indicate that accessibility barriers are systemic across Indonesian mobile banking platforms and, importantly, validate the decision to focus the evaluation on login, authentication, and core transactional features.

Five respondents (33.3%) reported not using mobile banking at all, citing distrust of application security, fear of fraud, and concerns about sharing devices with other household members. This highlights that accessibility alone is insufficient; trust and security perceptions must also be addressed to achieve true financial inclusion for visually impaired users.

When asked about desired features, respondents expressed a strong preference for interfaces designed specifically with blind users in mind, dark screen mode functionality, and screens that are genuinely easy to navigate with screen readers. These preferences directly informed the analytical focus of the main evaluation, particularly the emphasis on TalkBack compatibility, color contrast, and semantic structure. Table 4.2 presents the most frequently used mobile banking features reported by pilot survey respondents.

Table 4.2 Most frequently used features

| Feature             | Number of Users |
|---------------------|-----------------|
| Transfer money      | 8               |
| Check balance       | 7               |
| Top-up credit/data  | 6               |
| Pay bills           | 5               |
| Transaction history | 5               |
| Top-up e-wallet     | 4               |
| QRIS                | 2               |

The pilot survey does not stand alone as a separate report. Instead, it provides the user-grounded justification for four core elements of this research: (a) the selection of BRImo as the target application, justified by its highest usage frequency in Table 4.1; (b) the selection of the seven core features evaluated in this chapter, derived directly from the feature usage data; (c) the construction of the task scenarios used in User Testing A; and (d) the analytical emphasis on TalkBack labeling, color contrast, and semantic structure, which mirrors the difficulties and preferences reported by pilot respondents. In this way, the pilot survey operationalizes the conceptual framework presented in Chapter 2 by translating user needs into measurable independent variables (WCAG criteria, screen reader compatibility, visual design) and dependent variables (task completion, efficiency, satisfaction) that are evaluated in the remainder of this chapter.

### 4.3 Accessibility Evaluation of the Original BRImo Application

To comprehensively assess the accessibility of the original BRImo application for visually impaired users, a multi-method evaluation was conducted. Rather than relying on a single test or tool, the evaluation integrates five complementary approaches, each targeting a different dimension of accessibility. First, an automated accessibility scan using Google Accessibility Scanner provides a technical baseline of interface-level violations. Second, a manual TalkBack screen reader inspection captures the authentic auditory experience of a totally blind user navigating the application. Third, the identified barriers are systematically mapped against WCAG 2.1 success criteria to ground the findings in an internationally recognized standard. Fourth, color contrast analysis using the Colour Contrast Analyser addresses the visual design barriers most consequential for low-vision users. Fifth, User Testing A with six visually impaired participants validates and extends the inspection findings through real-world interaction observation. Together, these methods produce a triangulated,

evidence-based diagnosis of BRImo's accessibility strengths and weaknesses, forming the foundation for the redesign. The results of each evaluation component are reported in the following subsections.

#### 4.3.1 Automated Accessibility findings

The findings presented in this section are derived from the Google Accessibility Scanner, an automated evaluation tool employed as a supporting inspection instrument rather than a primary source of accessibility conclusions. As established in the methodology, automated tools capture only a subset of real-world accessibility barriers and cannot replicate the lived experience of visually impaired users navigating a mobile banking application with a screen reader (Lopes et al., 2022; Masrurroh et al., 2022). The automated findings reported here are therefore interpreted in conjunction with the manual TalkBack screen reader evaluation, Color Contrast Analyzer measurements, and WCAG 2.1 conformance assessment presented in subsequent sections, collectively constituting the multi-instrument inspection framework described in Stage 2 of the research procedure.

The Google Accessibility Scanner was used to evaluate the BRImo application across multiple screens and user flows. Due to security restrictions, some screens within the authentication process could not be captured via screenshots; however, the Accessibility Scanner remained capable of analyzing the UI structure and detecting accessibility issues on these pages. The scanner was run on each of the seven feature screens (login, home, transfer, top-up pulsa/data, transaction history, e-wallet, and QRIS), and the results are summarized in Table 4.3 below.

Table 4.3 Summary of Google accessibility scanner findings across seven BRImo features

| Issue Category | Description of Violation                                                                                            | Affected Features                                                  | WCAG 2.1 Criterion |
|----------------|---------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|--------------------|
| Item Label     | Interactive elements lack readable screen reader labels (announced only as "Tombol" or similar)                     | Home, Transfer, E-Wallet, QRIS                                     | 1.1.1, 4.1.2       |
| Text Scaling   | Text size uses dip (device-independent pixels) instead of sp (scalable pixels), ignoring user font size preferences | Login, Home, Transfer, Top-up, Transaction History, E-Wallet, QRIS | 1.4.4              |
| Touch Target   | Touch target height/dimensions below                                                                                | Login, Top-up, E-Wallet, QRIS                                      | 2.5.5              |

|                         |                                                                                      |                                                              |              |
|-------------------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------|--------------|
|                         | recommended minimum of 48dp                                                          |                                                              |              |
| Text Contrast           | Foreground/background contrast ratio below WCAG 2.1 Level AA (4.5:1 for normal text) | Login, Transfer, Transaction History                         | 1.4.3        |
| Image/Non-text Contrast | Contrast ratio for icons and graphical elements below 3:1                            | Login, Transfer, Top-up, Transaction History, E-Wallet, QRIS | 1.4.11       |
| Duplicate Descriptions  | Multiple items share the same speakable text, causing confusion                      | Transfer                                                     | 1.3.1, 2.4.4 |

The most critical finding from the automated scan is the widespread absence of descriptive item labels on interactive elements, affecting four of the seven features (home, transfer, e-wallet, and QRIS). This means that for a totally blind user navigating with TalkBack, many buttons will be announced only as “Tombol” (button) without any indication of their function. A barrier that directly violates WCAG 1.1.1 (Non-text Content) and 4.1.2 (Name, Role, Value). The second most pervasive issue is the use of dp instead of sp for text sizing, which affects all seven features. This prevents the application from respecting the user’s system-level font size preferences, making it difficult or impossible for low-vision users who require enlarged text to read the interface comfortably. Additionally, touch targets below 48dp appear on login, top-up, e-wallet, and QRIS screens, increasing the risk of accidental taps or missed activations. A particular problem for users with reduced motor control or those using the device with screen magnification.

The automated scan reveals that BRImo’s accessibility problems are not isolated to a single screen or feature. They are systemic, appearing across the entire application. The absence of item labels means that independent navigation for TalkBack users is severely compromised from the moment they open the app. The text scaling issue means that low-vision users who depend on larger fonts cannot rely on their own device settings to make BRImo readable. These are not minor cosmetic issues; they are fundamental violations of the Perceivable and Operable principles of WCAG 2.1. Without addressing these, BRImo cannot be considered genuinely accessible to Indonesia’s 8.02 million visually impaired citizens. The automated findings thus establish a clear, evidence-based justification for the manual TalkBack inspection and user testing.

### 4.3.2 TalkBack Screen Reader Findings

A manual screen reader evaluation was conducted by the researcher with TalkBack enabled on an Android device in exploration mode. For each of the seven core features (login, home, transfer, top-up, transaction history, e-wallet, and QRIS), the researcher navigated sequentially through every interactive and informational element, recording TalkBack's exact announcement. This method captures the authentic screen reader experience that a totally blind user would encounter, revealing barriers that automated tools cannot detect (e.g., mispronounced abbreviations, missing semantic structure). The findings are summarized in Table 4.4 below, which groups the identified issues by category across all features.

Table 4.4 Summary of TalkBack accessibility issues across seven BRImo features

| Issue Category                            | Example TalkBack Announcement                                                         | Affected Features                                                                                                               | WCAG 2.1 Criterion |
|-------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|--------------------|
| Unlabeled icon-only buttons               | "Tombol" (button) without function description                                        | Login (fingerprint), Home (notification, balance toggle), Transfer (back, status), Top-up (back, clear), E-Wallet (icons), QRIS | 1.1.1, 4.1.2       |
| Unintelligible technical string           | "com.google android material buat tomchid buat tomchid behavior"                      | QRIS bottom navigation                                                                                                          | 1.1.1, 4.1.2       |
| Abbreviation mispronounced as letters     | "Q-R-I-S", "B-R-I-V-A", "W-I-B" (instead of "QRIS", "BRIVA", "Waktu Indonesia Barat") | Login, Transaction History                                                                                                      | 1.3.1, 3.1.2       |
| Currency abbreviation mispronounced       | "Rop" (instead of "Rp" for Rupiah)                                                    | Transfer, E-Wallet, QRIS                                                                                                        | 3.1.2, 1.3.1       |
| Extra unintelligible text appended        | "Minimum sepuluh ribu untuk nol" (extra "untuk nol")                                  | Transfer, E-Wallet, QRIS                                                                                                        | 3.1.2, 1.3.1       |
| Missing semantic structure                | Date headers (e.g., "22 December 2025") not announced by TalkBack                     | Transaction History                                                                                                             | 1.3.1, 2.4.6       |
| Incorrect word pronunciation              | "Es-ta-te-ment" (for "e-statement")                                                   | Transaction History                                                                                                             | 3.1.2              |
| Generic announcement for state indicators | Colored circle (green/red) announced only as "Tombol"                                 | Transfer, Top-up                                                                                                                | 1.3.3, 4.1.2       |

The most severe barrier identified is the unintelligible technical string announced for the QRIS bottom navigation item. This is not merely an unlabeled button; TalkBack reads a meaningless string of code, making the QRIS feature effectively inaccessible to a blind user

unless they memorize the button’s position through trial and error. The second most pervasive issue is the announcement of icon-only buttons as generic “Tombol” across almost every feature. For a user who cannot see the screen, a fingerprint button, a back button, and a notification button all sound identical. There is no way to know which function each button performs without activating it and observing the result (or failing to do so). This directly violates WCAG 1.1.1 (Non-text Content) and 4.1.2 (Name, Role, Value). Additionally, the absence of semantic date headers in transaction history means that a blind user cannot tell which transactions occurred on which day. A fundamental piece of financial information that a sighted user sees at a glance. The mispronunciation of “QRIS” as individual letters and “Rp” as “Rop” adds unnecessary cognitive load, forcing the user to mentally translate the spoken output into the intended meaning.

The TalkBack inspection reveals that BRImo fails to provide the most basic requirement for screen reader accessibility: descriptive, functional labels for interactive elements. Without these, a totally blind user cannot navigate independently, confidently, or efficiently. The QRIS issue is particularly critical because it represents a complete breakdown of the Operable principle. A feature that is entirely unreachable through standard TalkBack navigation. The missing date headers violate the Understandable principle, as the user cannot properly interpret the transaction history. These are not edge cases; they affect every screen reader user who attempts to use BRImo. The findings from this manual inspection directly validate and extend the automated scanner results from Section 4.3.1, providing concrete, user-facing evidence of the accessibility barriers that will be further confirmed through participatory user testing in Section 4.3.5.

### **4.3.3 WCAG 2.1 Conformance Assessment**

The BRImo application was evaluated against WCAG 2.1 Level A and Level AA success criteria using the Harvard University WCAG 2.1 Vendor Checklist framework. Conformance was determined by triangulating evidence from the automated accessibility scan (Section 4.3.1), the manual TalkBack inspection (Section 4.3.2), and color contrast measurements (Section 4.3.4). Each criterion was rated using a four-level scale:

- a. Supports – The criterion is fully satisfied; no accessibility barriers observed.
- b. Does not Support – the criterion is not fully satisfied.
- c. Supports with Exceptions – The criterion is partially satisfied, meaning that while some elements or screens meet the requirement, specific, reproducible exceptions exist that

create barriers for visually impaired users. This indicates that the application does not fully conform to the criterion.

- d. Not Applicable – The criterion does not apply to BRImo (e.g., no audio or video content).

The phrase “Supports with Exceptions” is therefore functionally equivalent to “partially conforms” or “conditionally supports – does not fully conform due to identified exceptions.” It signals that a visually impaired user will encounter barriers on some but not all parts of the interface.

a. Level A Criteria Conformance Summary

Table 4.5 presents the conformance assessment results for all applicable WCAG 2.1 Level A success criteria, evaluated against the combined evidence gathered through TalkBack screen reader inspection, Google Accessibility Scanner findings, and Color Contrast Analyzer measurements.

Table 4.5 Level A criteria conformance summary

| Criteria                        | Conformance Level        | Key Findings                                                                |
|---------------------------------|--------------------------|-----------------------------------------------------------------------------|
| 1.1.1 Non-text Content          | Supports with Exceptions | Icon-only buttons (fingerprint, notification, back) lack alternative text   |
| 1.2.1 Audio-only and Video-only | Not Applicable           | No audio/video content present                                              |
| 1.2.2 Captions (Prerecorded)    | Not Applicable           | No video content present                                                    |
| 1.2.3 Audio Description         | Not Applicable           | No video content present                                                    |
| 1.3.1 Info and Relationships    | Supports with Exceptions | Multiple unlabeled elements; form groups not programmatically associated    |
| 1.3.2 Meaningful Sequence       | Supports with Exceptions | Logical order generally maintained but abbreviations read letter-by-letter  |
| 1.3.3 Sensory Characteristics   | Supports with Exceptions | Icon-only controls rely on visual position/ shape                           |
| 1.4.1 Use of Color              | Supports with Exceptions | Active/inactive states distinguished primarily by color                     |
| 1.4.2 Audio Control             | Not Applicable           | No auto-playing audio                                                       |
| 2.1.1 Keyboard                  | Supports with Exceptions | All functions operable but unlabeled controls reduce usability              |
| 2.1.2 No Keyboard Trap          | Supports                 | No focus traps detected                                                     |
| 2.1.4 Character Key Shortcuts   | Not Applicable           | No character key shortcuts implemented                                      |
| 2.2.1 Timing Adjustable         | Supports with Exceptions | Session timeouts for security without user adjustment (essential exception) |

|                              |                          |                                                                           |
|------------------------------|--------------------------|---------------------------------------------------------------------------|
| 2.2.2 Pause, Stop, Hide      | Supports                 | No auto-moving content beyond 5 seconds                                   |
| 2.3.1 Three Flashes          | Supports                 | No flashing content detected                                              |
| 2.4.1 Bypass Blocks          | Supports with Exceptions | No skip navigation mechanism; relies on screen reader techniques          |
| 2.4.2 Page Titled            | Supports with Exceptions | Some screens lack clear titles; titles not consistently announced         |
| 2.4.3 Focus Order            | Supports with Exceptions | Logical order maintained but unlabeled elements reduce clarity            |
| 2.4.4 Link Purpose           | Supports with Exceptions | Icon-only links lack purpose context                                      |
| 2.5.1 Pointer Gestures       | Supports                 | All functions operable with single-pointer gestures                       |
| 2.5.2 Pointer Cancellation   | Supports                 | Actions execute on up-event; confirmation steps provided                  |
| 2.5.3 Label in Name          | Supports with Exceptions | Icon-only controls violate; abbreviations read letter-by-letter           |
| 2.5.4 Motion Actuation       | Not Applicable           | No motion-based functionality                                             |
| 3.1.1 Language of Page       | Supports with Exceptions | Mixed Indonesian/English content not programmatically identified          |
| 3.2.1 On Focus               | Supports                 | No automatic context changes on focus                                     |
| 3.2.2 On Input               | Supports with Exceptions | Selection changes may cause navigation without warning                    |
| 3.3.1 Error Identification   | Supports with Exceptions | Error messages present but not programmatically linked to fields          |
| 3.3.2 Labels or Instructions | Supports with Exceptions | Placeholder text disappears; instructions not programmatically associated |
| 4.1.1 Parsing                | Supports                 | No parsing errors detected                                                |
| 4.1.2 Name, Role, Value      | Supports with Exceptions | Icon-only controls lack names; state changes not always announced         |

Table 4.5 indicates that the most relevant Level A criteria are classified as "Supports with Exceptions." The paramount exceptions pertain to criteria that directly influence screen reader usability: 1.1.1 (Non-text Content), 4.1.2 (Name, Role, Value), and 2.4.4 (Link Purpose). These exceptions pertain to the unlabeled icon-only buttons and the incomprehensible QRIS navigation announcement recorded in the TalkBack inspection (Section 4.3.2). What implications does this hold for the user? A visually impaired individual using BRImo will discover that certain buttons are accurately announced, whereas others, such as the fingerprint button, back button, and notification button are merely referred to as "Tombol," lacking any

functional context. This inconsistency contravenes the Predictability principle and compels the user to depend on memorized button placements instead of the interface's inherent communication. The significance of BRImo's accessibility is evident: without rectifying these exceptions, the application cannot be considered reliably functional for users who rely on TalkBack. Only seven criteria attain full "Supports" status, primarily involving interaction behaviors that are independent of labeling (e.g., 2.1.2 No Keyboard Trap, 2.3.1 Three Flashes). Six criteria are designated as "Not Applicable" due to the absence of audio, video, motion-based, or character shortcut functionalities in BRImo.

b. Level AA Criteria Conformance Summary

Table 4.6 presents the conformance assessment results for all applicable WCAG 2.1 Level AA success criteria, which address more advanced accessibility requirements, including color contrast, text resizing, consistent navigation, and error handling.

Table 4.6 Level AA criteria conformance summary

| Criteria                     | Conformance Level        | Key Findings                                                          |
|------------------------------|--------------------------|-----------------------------------------------------------------------|
| 1.2.4 Captions (Live)        | Not Applicable           | No live multimedia content                                            |
| 1.2.5 Audio Description      | Not Applicable           | No prerecorded video content                                          |
| 1.3.4 Orientation            | Supports with Exceptions | Landscape orientation partially supported with reduced usability      |
| 1.3.5 Identify Input Purpose | Supports with Exceptions | Input purposes not programmatically identifiable for autofill         |
| 1.4.3 Contrast (Minimum)     | Supports with Exceptions | Multiple text elements fail 4.5:1 contrast requirement                |
| 1.4.4 Resize Text            | Supports with Exceptions | Text truncation and overlap at higher zoom levels                     |
| 1.4.5 Images of Text         | Supports                 | Text implemented as actual text, not images                           |
| 1.4.10 Reflow                | Supports with Exceptions | Horizontal scrolling required on some screens at high zoom            |
| 1.4.11 Non-text Contrast     | Supports with Exceptions | UI component contrast below 3:1 for many elements                     |
| 1.4.12 Text Spacing          | Supports with Exceptions | Text overlap in dense UI areas when spacing increased                 |
| 1.4.13 Content on Hover      | Not Applicable           | No hover-triggered content                                            |
| 2.4.5 Multiple Ways          | Supports with Exceptions | Limited alternative navigation paths; no search function              |
| 2.4.6 Headings and Labels    | Supports with Exceptions | Inconsistent heading structure; vague labels on some screens          |
| 2.4.7 Focus Visible          | Supports with Exceptions | Focus indicators present but low contrast and subtle                  |
| 3.1.2 Language of Parts      | Supports with Exceptions | Mixed-language content not identified                                 |
| 3.2.3 Consistent Navigation  | Supports with Exceptions | Navigation consistent on main screens but varies on secondary screens |

|                                 |                          |                                                                |
|---------------------------------|--------------------------|----------------------------------------------------------------|
| 3.2.4 Consistent Identification | Supports with Exceptions | Same functions identified inconsistently across screens        |
| 3.3.3 Error Suggestion          | Supports with Exceptions | Generic error messages without specific correction suggestions |
| 3.3.4 Error Prevention          | Supports                 | Confirmation screens before financial transactions             |
| 4.1.3 Status Messages           | Supports with Exceptions | Some status messages not automatically announced               |

As presented in Table 4.6, the Level AA assessment reveals that BRImo achieves full "Supports" status on only two criteria 1.4.5 Images of Text and 3.3.4 Error Prevention the latter reflecting the application's consistent provision of transaction confirmation screens before financial execution. The remaining applicable criteria are uniformly rated "Supports with Exceptions," with the most consequential failures concentrated in the visual design dimension: 1.4.3 Contrast Minimum, 1.4.11 Non-text Contrast, 1.4.4 Resize Text, and 1.4.12 Text Spacing collectively indicate that BRImo's visual presentation is not reliably accessible to low-vision users across varying display conditions. Three criteria are rated "Not Applicable" as they address live multimedia and hover-triggered content that BRImo does not implement.

The WCAG 2.1 conformance assessment reveals that across both Level A and Level AA, the majority of applicable success criteria are rated "Supports with Exceptions," indicating partial compliance where some interface elements or screens meet the criterion while others do not. Full "Supports" status is achieved on nine criteria in total, primarily those addressing interaction behaviors that do not depend on accessible labeling or visual design such as 2.1.2 No Keyboard Trap, 2.3.1 Three Flashes, 3.2.1 On Focus, and 4.1.1 Parsing at Level A, and 1.4.5 Images of Text and 3.3.4 Error Prevention at Level AA. This pattern of widespread partial conformance rather than outright failure reflects BRImo's status as an application with foundational accessibility support that is inconsistently implemented across features and screens. The most critically non-conformant criteria are 1.1.1 Non-text Content, 4.1.2 Name Role Value, and 1.4.3 Contrast Minimum, each of which directly affects the ability of visually impaired users to perceive and operate the application through assistive technology.

#### 4.3.4 Color Contrast Analysis Findings

Color contrast analysis was conducted using the Color Contrast Analyzer (CCA) tool across all seven BRImo feature screens. Each measured foreground/background pair was evaluated against WCAG 2.1 Level AA thresholds: 4.5:1 for normal text (criterion 1.4.3), 3:1 for large text (criterion 1.4.3), and 3:1 for non-text elements such as icons and form controls

(criterion 1.4.11). This analysis is critical for low-vision users, who may retain partial sight but cannot distinguish elements with insufficient contrast.

Table 4.7 Summary of critical color contrast failures across BRIimo features

| Severity                        | Element Description        | Screen          | Measured Ratio | Required Ratio (WCAG 2.1)    | Affected User Group |
|---------------------------------|----------------------------|-----------------|----------------|------------------------------|---------------------|
| Critical<br>( $< 1.5:1$ )       | Recipient Avatar           | Transfer Detail | 1.053:1        | 3:1 (non-text)               | Low vision          |
|                                 | Menu Icon Background       | Transfer Menu   | 1.157:1        | 3:1 (non-text)               | Low vision          |
|                                 | Active Tab Background      | Transfer Detail | 1.246:1        | 3:1 (non-text)               | Low vision          |
|                                 | Login screen text          | Login           | 1.15:1         | 4.5:1 (text)                 | Low vision          |
|                                 | Recent Transfer Card       | Transfer Detail | 1.129:1        | 3:1 (non-text)               | Low vision          |
|                                 | Inactive Tab Background    | Add Recipient   | 1.555:1        | 3:1 (non-text)               | Low vision          |
| High<br>( $1.5:1 - 2.5:1$ )     | Favorite Indicator Star    | Check Balance   | 1.881:1        | 3:1 (non-text)               | Low vision          |
|                                 | Gopay Logo                 | E-Wallet        | 2.577:1        | 3:1 (non-text)               | Low vision          |
|                                 | Menu Icon (Wallet)         | Transfer Menu   | 2.021:1        | 3:1 (non-text)               | Low vision          |
|                                 | DANA Logo                  | E-Wallet        | 2.377:1        | 3:1 (non-text)               | Low vision          |
|                                 | Disabled Button Background | Add Recipient   | 1.717:1        | 3:1 (non-text)               | Low vision          |
| Moderate<br>( $2.5:1 - 4.0:1$ ) | Primary Button Label       | Check Balance   | 3.294:1        | 4.5:1 (text) – <i>fail</i>   | Low vision          |
|                                 | Inactive Tab Label         | Transfer Detail | 3.617:1        | 4.5:1 (text) – <i>fail</i>   | Low vision          |
|                                 | Search Placeholder         | Transfer Detail | 3.234:1        | 4.5:1 (text) – <i>fail</i>   | Low vision          |
|                                 | Gopay Icon                 | E-Wallet        | 2.663:1        | 3:1 (non-text) – <i>fail</i> | Low vision          |

Table 4.7 reveals that BRIimo contains multiple critical contrast failures with ratios as low as 1.053:1 far below the WCAG 2.1 minimum of 3:1 for non-text elements and 4.5:1 for normal text. The most severe failures are concentrated in the transfer flow (recipient avatar, active tab background, recent transfer card) and the login screen (text contrast at 1.15:1). What does this mean for a low-vision user? Elements that should be clearly visible such as which tab is active, where to tap, or what text to read become ambiguous or completely invisible. A user with cataracts or diabetic retinopathy may see only a blurred or washed-out interface, forcing

them to guess, strain their eyes, or abandon the task. The importance of these failures for BRI'mo's accessibility is that they directly violate the Perceivable principle of WCAG 2.1. Unlike totally blind users who rely on TalkBack, low-vision users depend on visual contrast as their primary mode of interaction. When contrast fails, they are effectively excluded from independent use. The summary table also shows that failures are not isolated to one screen but are systemic across login, transfer, check balance, add recipient, and e-wallet features, indicating a pattern of design decisions that prioritize brand aesthetics over accessibility.

Indonesia has an estimated 6.36 million people with moderate to severe visual impairment (Rif'Ati et al., 2021). Many of these individuals are low-vision users who do not rely exclusively on the screen readers but need high contrast, large text, and clear visual boundaries. The contrast failures documented in Table 4.7 mean that for these millions of potential users, BRI'mo is visually inaccessible in its current state. A user cannot independently check their balance if the text is illegible, cannot transfer funds if the active tab is indistinguishable, and cannot top up an e-wallet if the provider logos blend into the background. These are not minor inconveniences; they are fundamental barriers to financial inclusion. The findings directly inform the redesign, where each failing color pair will be adjusted to meet at least WCAG 2.1 Level AA (4.5:1 for text, 3:1 for non-text), with Level AAA (7:1 for text, 4.5:1 for large text) achieved where feasible without compromising brand identity.

#### **4.3.5 User Testing A Findings**

The results of User Testing A, conducted with six visually impaired participants who interacted with the live BRI'mo application using their own Android devices and personal BRI accounts. This section reports participant demographics, task completion outcomes, critical accessibility barriers observed during testing, qualitative feedback gathered through the think-aloud protocol, System Usability Scale scores, and user persona profiles derived from the evaluation data. Collectively, these findings validate and extend the inspection results presented in Sections 4.3.1 through 4.3.4 by confirming that the technical barriers identified through automated scanning, TalkBack inspection, WCAG assessment, and contrast analysis translate into real and measurable interaction difficulties for visually impaired users conducting authentic banking tasks.

##### **a. Participant Demographics**

Table 4.8 presents the demographic profile of all six User Testing A participants, including their visual status, device used, and assistive technology configuration.

Table 4.8 Participant demographics for User Testing A

| Participant | Age | Gender | Occupation       | Vision Level    | Device               | Screen Reader      |
|-------------|-----|--------|------------------|-----------------|----------------------|--------------------|
| P01         | 24  | Male   | Software Testing | Total blindness | Galaxy (Android 16)  | TalkBack (full)    |
| P02         | 30  | Male   | Teacher          | Low vision      | Vivo (Android 12)    | None (screen only) |
| P03         | 30  | Male   | -                | Low vision      | Samsung (Android 14) | TalkBack + screen  |
| P04         | 25  | Male   | Student          | Total blindness | Samsung (Android 14) | TalkBack (full)    |
| P05         | 27  | Male   | Teacher          | Total blindness | Vivo (Android 11)    | TalkBack (full)    |
| P06         | 30  | Male   | Writer           | Total blindness | Infinix (Android 15) | TalkBack (full)    |

As shown in Table 4.8, the participant group comprises four totally blind users (P01, P04, P05, P06) who rely exclusively on TalkBack, one low-vision user with no screen reader (P02), and one low-vision user employing a combination of TalkBack and direct visual interaction (P03). This composition reflects the diversity of assistive technology usage patterns among visually impaired mobile banking users and ensures that evaluation findings capture barriers relevant to both TalkBack-dependent and visually-oriented interaction modes.

#### b. Task Completion Results

Table 4.9 shows the individual task completion times for all six participants in User Testing A, illustrating the variation in efficiency across different features and user configurations.

Table 4.9 Task completion results in user testing A

| Task                | P01   | P02    | P03   | P04 | P05 | P06 | Average Time |
|---------------------|-------|--------|-------|-----|-----|-----|--------------|
| Login               | 9.25s | 12.71s | 6.91s | 64s | 31s | 30s | 25.65s       |
| Check Balance       | 4s    | 3s     | 5s    | 25s | 10s | 30s | 12.83s       |
| Transfer Money      | 50s   | 57.94s | 106s  | 49s | 65s | 67s | 65.82s       |
| Top-up E-money      | 50s   | 75s    | 94s   | 50s | 60s | 69s | 66.33s       |
| Transaction History | 3s    | 3s     | 8s    | 54s | 8s  | 5s  | 13.5s        |
| Top-up Pulsa/Data   | 66s   | 66s    | 105s  | 56s | 85s | 85s | 77.17s       |
| QRIS                | 59s   | 53s    | 87s   | 69s | 56s | 56s | 63.33s       |

All six participants ultimately completed all seven banking tasks, yielding a 100% task completion rate across the evaluation. However, this outcome must be interpreted with significant caution and should not be read as an indicator that BRIimo is fully accessible to visually impaired users. Task completion in this context reflects participants' capacity to reach a successful outcome through persistence, compensatory strategies, prior familiarity with the application, or reliance on memorized interaction patterns rather than evidence of barrier-free, independent, and efficient access. The distinction between completion and accessibility is theoretically grounded in Khowaja et al. (2019), who demonstrate that high task completion rates and accessible design are distinct constructs that do not necessarily correlate, particularly when users with disabilities employ workaround behaviors to circumvent interface barriers.

As evidenced in the think-aloud data and evaluation matrix observations, several tasks were completed with difficulty, with notable time variation, or with partial reliance on researcher assistance. The QRIS task required assistance from four of the six participants. The highest rate of any task yet still registers as 100% complete in the task completion metric. Totally blind participants required an average of 33.6 seconds to complete the login task compared to 9.8 seconds for low-vision participants, reflecting the disproportionate interaction burden imposed by unlabeled elements on TalkBack-dependent users. The fund transfer task showed the widest time variation across participants (49 to 106 seconds), indicating that while all participants could eventually complete the task, the interaction experience was far from uniform or reliably efficient. These observations collectively demonstrate that task completion rate, when used in isolation, systematically underreports the severity of accessibility barriers encountered by visually impaired users in real banking interaction contexts.

Table 4.10 Task completion summary in user testing A

| Task                | Completion Rate | Assistance Needed | Key Observations                                                                   |
|---------------------|-----------------|-------------------|------------------------------------------------------------------------------------|
| Login               | 100%            | None              | Totally blind users took longer (average 33.6) compared to low vision users (9.8s) |
| Check Balance       | 100%            | None              | All users completed within expected timeframe                                      |
| Transfer Money      | 100%            | None              | Times varied significantly (49s to 106s)                                           |
| Top-up E-money      | 100%            | 1 user (P02)      | First-time users required more time to locate features                             |
| Transaction History | 100%            | None              | Most users completed quickly                                                       |
| Top-up Pulsa/Data   | 100%            | 1 user (P02)      | First-time users required guidance                                                 |

|      |      |                              |                                                              |
|------|------|------------------------------|--------------------------------------------------------------|
| QRIS | 100% | 4 users (P01, P03, P04, P06) | Assistance needed for scanning QR code or locating QRIS menu |
|------|------|------------------------------|--------------------------------------------------------------|

Notwithstanding the 100% task completion rate, the evaluation identified several critical accessibility barriers that substantially compromised the independence, efficiency, and confidence of visually impaired users during task execution. These barriers are classified as critical on the basis that they directly impede TalkBack navigation, prevent accurate interpretation of interface content, or require compensatory workaround behavior that would not be necessary in a fully accessible application.

The most frequently reported critical barrier was the announcement of interactive buttons exclusively as "Tombol" (button) without any descriptive label indicating the element's function. This issue affected the fingerprint authentication button, the balance visibility toggle, the back navigation button, the clear field button in the top-up flow, and transaction status indicators. All of which were announced identically as "Tombol," rendering them functionally indistinguishable to TalkBack-dependent users. Five of the six participants encountered this barrier across multiple features, and it was explicitly cited in think-aloud narrations as a source of confusion and additional navigation effort.

The second critical barrier was the QRIS bottom navigation item, which TalkBack announced as an unintelligible technical string, specifically "com.google android material buat tomchid buat tomchid behavior" rather than any meaningful label. This rendered the QRIS feature effectively inaccessible through TalkBack navigation alone, requiring researcher assistance or prior memorization of the button's position for four of the six participants to locate and activate it.

The third critical barrier concerned the absence of semantic date headers in the transaction history screen. Although transactions were visually grouped by date, these groupings were not announced by TalkBack, so blind users could not determine the chronological context of individual transactions without manually counting through the entries. A significant impediment in a banking context where transaction dating is financially consequential.

Additional critical barriers included pervasive color contrast failures across multiple screens with measured ratios as low as 1.053:1 against the WCAG 2.1 minimum of 4.5:1 for text and 3:1 for non-text elements touch targets below the 48dp minimum on multiple interactive elements, and text sizing specified in density-independent pixels (dip) rather than

scalable pixels (sp), preventing text from scaling in response to users' system font size preferences.

c. Think-Aloud Feedback Summary

Think-aloud data collected during User Testing A revealed a pattern of mixed responses across the six participants, with participants expressing general confidence and familiarity with the BRImo application while simultaneously reporting specific interaction barriers related to TalkBack label accuracy, navigational complexity, and assistive technology compatibility. Positive feedback centered primarily on participants' overall sense of security and trust in the application as a banking platform, while negative feedback consistently identified screen reader labeling failures and feature discoverability as the most significant sources of interaction difficulty.

Positive feedback expressed during the think-aloud sessions centered on participants' overall sense of security and confidence in using BRImo as a banking platform. Several participants verbalized that they felt safe using the application and perceived it as trustworthy for conducting financial transactions. Participants P03 and P04 specifically noted that TalkBack remained responsive and functional across different versions of the application, indicating a degree of screen reader compatibility that they valued in their regular banking experience. These positive responses were predominantly associated with the application's core transactional reliability rather than its interface accessibility, suggesting that participants' favorable impressions were shaped by their functional familiarity with BRImo rather than by the absence of accessibility barriers.

In contrast, negative feedback and reported accessibility barriers were more specific and directly tied to TalkBack interaction failures encountered during task execution. Table 4.11 summarizes the key issues reported by each participant during the testing session.

Table 4.11 Negative feedback and reported issues during user testing A

| Participant | Reported Issue                                                                                                   |
|-------------|------------------------------------------------------------------------------------------------------------------|
| P01         | Fingerprint not read by TalkBack; QRIS menu name not readable; first-time use of pulsa/data requires more effort |
| P02         | Typo errors (especially PIN entry); unfamiliar features require guidance                                         |
| P03         | Cross/close button in transfer not readable on his device; QR code difficult to locate                           |
| P04         | Top-up requires reading all options (time-consuming)                                                             |
| P05         | Wants fingerprint button to be readable by TalkBack                                                              |

|     |                                                                                                                                                                                                |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P06 | Screen reader from China (Jieshuo) blocked; QRIS button reads incomprehensible text; copy-paste for account numbers unreliable; relies on recent transfer list to avoid typing account numbers |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Across all six participants, the most consistently reported barriers involved TalkBack label failures. Particularly, the fingerprint authentication button, QRIS navigation item, transaction status indicators, and navigational complexity encountered during first-time feature interactions. Participant P06's report of an unintelligible QRIS button announcement and unreliable copy-paste functionality for account numbers represents particularly consequential barriers, as these directly prevent independent task completion without compensatory strategies or prior feature memorization. These qualitative observations directly corroborate the critical barriers identified through the systematic TalkBack inspection and WCAG 2.1 conformance assessment, confirming that the labeling deficiencies documented in the evaluation matrix translate into real and measurable user difficulty during authentic banking task execution.

Cross-participant analysis of the think-aloud data revealed five accessibility issues that were independently reported by multiple participants, indicating that these barriers represent consistent and reproducible challenges rather than isolated individual experiences. The most frequently cited issue was the absence of a descriptive TalkBack announcement for the fingerprint authentication button, which was reported by five of the six participants as a source of confusion during the login task. The QRIS bottom navigation item announced by TalkBack as an unintelligible technical string rather than a meaningful label was identified as effectively inaccessible through screen reader navigation by four participants, representing the most severe single barrier encountered across all seven features. Three participants independently reported that entering account numbers digit-by-digit through TalkBack's character-by-character reading mode imposed a disproportionate cognitive and interaction burden, significantly extending task completion time for the fund transfer feature. Copy-paste functionality for account numbers was identified by two participants as unreliable under TalkBack, with clipboard operations either failing to execute or not being confirmed through auditory feedback, forcing manual digit-by-digit re-entry.

#### d. System Usability Scale (SUS) Results

The System Usability Scale (SUS) questionnaire was administered to all six participants. Scores were calculated using the standard SUS scoring method. Table 4.12 presents individual participant responses to each of the ten SUS items, providing the raw data from which SUS scores are calculated in Table 4.13.

## 1. Individual SUS Scores

Table 4.12 Individual SUS scores

| Statement                                      | P01 | P02 | P03 | P04 | P05 | P06 |
|------------------------------------------------|-----|-----|-----|-----|-----|-----|
| I think I would use this app frequently        | 4   | 4   | 5   | 5   | 5   | 5   |
| I found the app unnecessarily complex          | 1   | 2   | 2   | 1   | 1   | 1   |
| I thought the app was easy to use              | 5   | 4   | 4   | 5   | 5   | 5   |
| I would need technical support to use this app | 1   | 3   | 2   | 1   | 1   | 2   |
| I found the functions well integrated          | 5   | 4   | 4   | 5   | 5   | 4   |
| I thought there was too much inconsistency     | 1   | 2   | 5   | 1   | 1   | 2   |
| Most people would learn this app quickly       | 5   | 5   | 4   | 5   | 5   | 3   |
| I found the app cumbersome to use              | 1   | 1   | 2   | 1   | 1   | 1   |
| I felt confident using the app                 | 4   | 4   | 5   | 5   | 5   | 5   |
| I needed to learn a lot before using this app  | 2   | 4   | 2   | 4   | 5   | 2   |

## 2. SUS Score Calculation

Table 4.13 SUS score calculation

| Participant | Raw Score | SUS Score (0-100) |
|-------------|-----------|-------------------|
| P01         | 37        | 92.5              |
| P02         | 29        | 72.5              |
| P03         | 29        | 72.5              |
| P04         | 37        | 92.5              |
| P05         | 36        | 90.0              |
| P06         | 34        | 85.0              |

The mean SUS score of 84.17, corresponding to a grade of A and an adjective rating of "Excellent" on the Bangor et al. (2009) classification scale, indicates that participants perceived the overall usability of BRImo as acceptable. However, this score requires careful contextual interpretation and should not be read as evidence that BRImo presents minimal accessibility challenges for visually impaired users.

Several factors contribute to the apparent discrepancy between the relatively favorable SUS score and the critical accessibility barriers documented through TalkBack inspection and think-aloud observation. First, SUS measures perceived usability, which is the user's subjective overall impression of the system, rather than objectively measuring the presence or severity of accessibility barriers. Participants who have used BRImo repeatedly before testing may have developed familiarity-based compensatory strategies that reduce their subjective sense of difficulty even when navigating around persistent barriers. Second, four of the six participants are totally blind TalkBack users who reported positive sentiments about the application's general responsiveness and their sense of security using it dimensions well captured by SUS

items such as "I felt confident using the app" and "I think I would use this app frequently" while simultaneously encountering significant screen reader labeling barriers that the SUS instrument is not specifically designed to detect.

These observations align with the theoretical argument advanced by Khowaja et al. (2019) and empirically supported by Huq et al. (2026) that standardized usability metrics such as SUS do not fully capture the severity of accessibility barriers experienced by screen reader users, as these barriers often manifest in ways increased cognitive load, extend navigation paths, and rely on memorization. The users may not fully attribute the application in their retrospective self-report. The SUS score of 84.17 should therefore be interpreted as reflecting participants' overall perceived satisfaction and functional familiarity with BRImo, while the critical barriers documented through the inspection and observational data represent the accessibility dimension of the evaluation that SUS alone cannot adequately convey.

#### e. User Persona Summary

Based on the user testing and pilot survey data, two primary user personas were identified. Each represents a distinct pattern of assistive technology use, interaction behavior, and accessibility barrier experience among visually impaired BRImo users.

The first persona is the totally blind user, characterized by exclusive reliance on TalkBack as the sole mode of mobile interface interaction. Users in this group navigate BRImo entirely through sequential swipe gestures and TalkBack audio announcements, with no access to visual interface cues. As a result of extended experience with the application, these users tend to memorize screen layouts and button positions, enabling them to navigate familiar features efficiently despite the presence of unlabeled elements. Rather than typing account numbers or transaction details manually. A process complicated by TalkBack's digit-by-digit reading behavior and the cognitive load of error correction. These users consistently prefer to rely on recently saved recipients, transaction history, or clipboard data to minimize manual input. Consistency of interface structure and TalkBack announcement behavior across screens is particularly valued by this group, as any variation in element positioning or label phrasing disrupts memorized navigation patterns and requires additional exploratory interaction to reorient.

The second persona is the low-vision user, who employs a hybrid interaction mode combining direct visual perception with selective assistive technology use. Unlike totally blind users, low-vision users retain partial functional vision and use visual cues, including color, icon position, text size, and layout structure, for initial screen orientation before activating TalkBack

or screen magnification for elements that are visually unclear or insufficiently contrasted. This interaction pattern means that low-vision users are disproportionately affected by visual design deficiencies such as low color contrast, non-scalable text, and dense layout spacing. While being less dependent on descriptive TalkBack labels for basic navigation. Users in this group demonstrated greater initial task efficiency than totally blind participants in this study, but reported frustration with color contrast failures and input errors arising from reduced visual acuity during precise text entry tasks. Their accessibility experience underscores that visual design accessibility and screen reader accessibility are complementary rather than interchangeable dimensions of inclusive mobile banking design, and that addressing one without the other leaves a significant segment of the visually impaired user population inadequately served.

The user testing results presented in this section collectively confirm that the accessibility barriers identified through the systematic inspection phases are not theoretical concerns but genuine impediments to real-world mobile banking interaction. The 100% task completion rate, while superficially positive, conceals substantial variation in interaction efficiency and independence, particularly for totally blind TalkBack-dependent users who required significantly more time and compensatory effort than low-vision participants. The SUS mean of 84.17 reflects perceived usability shaped by familiarity rather than the absence of barriers, as evidenced by the lower scores of P02 and P03, who encountered the most severe navigation difficulties. These findings, in conjunction with the inspection and conformance assessment results, establish a comprehensive evidence base for the redesign recommendations.

#### **4.3.6 Discussion: Synthesis of Evaluation Findings**

The five evaluation instruments employed in this chapter are a pilot survey, automated accessibility scanning, manual TalkBack screen reader inspection, WCAG 2.1 conformance assessment, and participatory user testing. Collectively produce a convergent and multi-dimensional picture of BRImo's current accessibility status for visually impaired users. This four-source convergence on a single barrier type represents the most robustly evidenced accessibility deficiency in the current BRImo application and is identified as the highest-priority area for improvement in the prototype redesign recommendations.

Convergence across instruments. The most consistent finding across all five evaluation sources is the pervasive failure of interactive elements to carry descriptive accessible labels for TalkBack announcement. This barrier was flagged by the Google Accessibility Scanner as

"Item Label" violations across six feature screens, documented in the TalkBack flow inspection as repeated "Tombol" announcements across all seven features, classified under WCAG 2.1 criteria 1.1.1 Non-text Content, 1.3.1 Info and Relationships, 2.4.4 Link Purpose, and 4.1.2 Name Role Value as "Supports with Exceptions," and confirmed through think-aloud narrations by five of the six User Testing A participants as a direct source of navigational confusion and additional interaction effort. This four-source convergence on a single barrier type represents the most robustly evidenced accessibility deficiency in the current BRImo application and constitutes the highest-priority target for remediation in the prototype redesign phase.

The task completion paradox. The 100% task completion rate observed in User Testing A, while consistent with the pilot survey finding that 73.3% of visually impaired respondents actively use mobile banking applications, does not reflect a barrier-free interaction experience. As the WCAG 2.1 conformance assessment reveals, only nine success criteria across all evaluated features achieved full "Supports" status, while the majority of applicable criteria were rated "Supports with Exceptions." This pattern indicates that BRImo provides partial accessibility support sufficient for task completion under conditions of user familiarity and compensatory strategy deployment, but falls substantially short of the consistent, independent, and efficient access that WCAG 2.1 Level AA compliance is designed to ensure. The 100% completion rate. Therefore, reflects the resilience and adaptive capacity of visually impaired users rather than the accessibility quality of the application, and must not be interpreted as evidence of adequate accessibility conformance.

Persona-specific barrier patterns. The two user personas identified in this evaluation exhibit qualitatively distinct barrier experiences that collectively inform the scope of the prototype redesign. Totally blind TalkBack-dependent users are most critically affected by screen reader labeling failures, unintelligible element announcements, absent semantic structure, and inconsistent navigation behavior barriers that are addressed at the design specification level through WCAG 2.1-aligned recommendations targeting criteria 1.1.1, 1.3.1, 2.4.4, and 4.1.2. Low-vision users are most critically affected by color contrast failures, non-scalable text, and insufficient touch target dimensions. The barriers that are addressed through visual design improvements incorporated into the Figma prototype and validated through User Testing B, aligned with WCAG 2.1 criteria 1.4.3, 1.4.4, 1.4.11, 1.4.12, and 2.5.5. The prototype redesign incorporates evidence-based improvements targeting both user groups; however, as elaborated in the research limitations, TalkBack-specific improvements are assessed through

design inspection rather than live screen reader validation, and their empirical effectiveness requires verification through implementation in a fully developed native Android application.

The identified accessibility barriers are categorized by severity in Tables 4.14 and 4.15 below, distinguishing between issues classified as critical and those classified as high priority for improvement. Table 4.16 further contextualizes these findings by comparing the evaluation results against the accessibility difficulties reported in the preliminary pilot survey, confirming the ecological validity of the formal evaluation findings.

Table 4.14 Critical Issues requiring immediate attention

| Issue                                                              | Impact                                                          | Affected Users          |
|--------------------------------------------------------------------|-----------------------------------------------------------------|-------------------------|
| Icon-only buttons without labels (fingerprint, back, notification) | Users cannot identify button functions                          | All screen reader users |
| QRIS menu item not readable (announces as technical string)        | QRIS feature inaccessible from bottom navigation via Talkback   | All screen reader users |
| Missing date headers in transaction history                        | Users cannot identify chronological context of transaction      | All screen reader users |
| Low contrast for critical UI elements                              | Reduced visual legibility for low-vision users                  | Low vision users        |
| Inconsistent reading of abbreviations (QRIS, BRIVA)                | Reduced comprehension of interface content                      | All screen reader users |
| "Rp" pronounced as "Rop"                                           | Confusion about currency amounts during financial transactions. | All screen reader users |

As illustrated in Table 4.14, the most critical barriers are concentrated in the Perceivable and Operable WCAG principles, affecting both totally blind and low-vision users across multiple features. High-priority issues identified for improvement are summarized in Table 4.15.

Table 4.15 High priority issues

| Issue                                                  | Impact                                              | Affected Users                                  |
|--------------------------------------------------------|-----------------------------------------------------|-------------------------------------------------|
| Touch targets below 48dp minimum                       | Difficulty activating controls precisely            | Low vision users , Users with motor impairments |
| Text using dip instead of sp                           | Text does not respond to user font size preferences | Low vision users                                |
| Placeholder text disappears when typing                | Loss of field context during data entry review      | All screen reader users                         |
| Mixed-language content not programmatically identified | Incorrect pronunciation by Talkback text-to-speech  | All screen reader users                         |

|                                                       |                                                      |                         |
|-------------------------------------------------------|------------------------------------------------------|-------------------------|
| Missing programmatic associations for errors messages | Users must search manually for error source          | All screen reader users |
| Insufficient contrast for normal text elements        | Reduced readability under varied lighting conditions | Low vision users        |
| Unclear focus indicators                              | Difficulty tracking focus position during navigation | Low vision users        |

Table 4.16 contextualizes the formal evaluation findings against the preliminary accessibility difficulties reported by pilot survey respondents, confirming that the barriers identified through systematic inspection and user testing are consistent with the real-world accessibility challenges experienced by visually impaired BRImo users before the formal study.

Table 4.16 Comparison with pilot survey findings

| Survey Finding                                            | Confirmed in BRImo Evaluation                                                                                    |
|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| Difficulties during login process                         | Fingerprint button unlabeled; username field reading issues confirm through Talkback inspection                  |
| Expectation that all menus should be readable by Talkback | QRIS menu item not readable; icon-only buttons lack descriptive labels across all features                       |
| Transfer recipient fields not readable                    | Account number field reading inconsistent; “Rp” mispronounced as “Rop”                                           |
| Need for dark screen mode functionality                   | Not within evaluation scope but consistently requested by survey respondents                                     |
| Features should be accessible and not difficult to use    | Generally positive SUS scores but with significant navigation friction points confirmed through think-aloud data |

The convergence between pilot survey findings and formal evaluation results strengthens the ecological validity of this research, confirming that the accessibility barriers identified through systematic TalkBack inspection and participatory user testing reflect genuine and persistent challenges encountered by visually impaired users in real-world BRImo usage. Collectively, these findings indicate that while BRImo demonstrates sufficient functional accessibility to enable task completion by experienced users employing compensatory strategies, it falls considerably short of the consistent, independent, and efficient access that WCAG 2.1 Level AA compliance requires.

## CHAPTER V

### CONCLUSION AND SUGGESTIONS

#### 5.1 Conclusions

This research conducted a comprehensive accessibility evaluation of the BRImo mobile banking application for visually impaired users, employing a two-phase methodology: a systematic TalkBack accessibility inspection benchmarked against WCAG 2.1 Level AA, and participatory User Testing A with six visually impaired participants. The conclusions below are organized in direct response to the four research questions established in Chapter I, followed by a synthesizing answer to the main research question.

a. Research Question 1: Accessibility barriers in BRImo for visually impaired users

The systematic TalkBack inspection and User Testing A with six visually impaired participants identified multiple accessibility barriers across all seven evaluated features. The most critical barriers were: icon-only buttons announced exclusively as "Tombol" without descriptive labels, affecting the fingerprint, back, notification, balance toggle, and clear field buttons; the QRIS bottom navigation item announced as an unintelligible technical string; the absence of semantic date headers in transaction history; pervasive color contrast failures with ratios as low as 1.053:1 against the WCAG 2.1 minimum; touch targets below the 48dp minimum; and text sized in density-independent pixels rather than scalable pixels. All six participants completed all seven tasks, achieving a 100% task completion rate. However, this outcome must not be interpreted as evidence of full accessibility compliance. Task completion was achieved through persistence, compensatory strategies, and prior application familiarity not through barrier-free independent access. Task completion and accessibility compliance are distinct constructs, and the former does not imply the latter.

b. Research Question 2: WCAG 2.1 Level AA conformance of BRImo

WCAG 2.1 conformance assessment, grounded in evidence from TalkBack inspection, Google Accessibility Scanner, and Color Contrast Analyzer, revealed that the majority of applicable Level A and Level AA success criteria are rated "Supports with Exceptions", indicating partial conformance where some elements meet the criterion while others do not. Full "Supports" status was achieved on only nine criteria, predominantly those addressing interaction behaviors independent of accessible labeling or visual design. Organizing findings by the four POUR principles reveals the following pattern. Under the Perceivable principle, the most critical failures were 1.1.1 Non-text Content with icon-only buttons carrying no

descriptive alternative text and 1.4.3 Contrast Minimum, where contrast ratios as low as 1.053:1 were recorded against the 4.5:1 threshold, affecting readability for low-vision users across multiple screens. Under the Operable principle, failures were identified in 2.5.5 Target Size, where interactive touch targets fell below the 48dp minimum, increasing interaction error rates, particularly for low-vision users with reduced motor precision. Under the Understandable principle, the absence of semantic date headers in transaction history prevented users from independently determining the chronological context of their transactions, and text sized in density-independent pixels rather than scalable pixels prevented system font size preferences from taking effect. Under the Robust principle, the most critically non-conformant criterion was 4.1.2 Name Role Value, which governs programmatic labeling of interface element failures here directly causing TalkBack to announce buttons as "Tombol" without context and to render the QRIS navigation item as an unintelligible technical string. This pattern of widespread partial conformance across all four POUR dimensions confirms that BRImo has foundational accessibility support that is inconsistently implemented across features and screens.

c. Research Question 3: Real-world experience of accessibility barriers during User Testing A

User Testing A with six visually impaired participants: four totally blind and two low vision, validated and extended the inspection findings by revealing how identified barriers manifest in real interaction. Although all six participants achieved 100% task completion, this outcome reflects task persistence, compensatory strategies, and prior application familiarity rather than barrier-free independent access. Totally blind participants encountered the most severe difficulties: unlabeled buttons required repeated exploratory swiping to identify their function, the unintelligible QRIS announcement caused disorientation during navigation, and the absence of semantic structure in transaction history forced participants to listen through entire lists sequentially to locate specific entries. Low-vision participants reported distinct but equally significant difficulties, including insufficient contrast that rendered balance figures and transaction amounts difficult to read even with screen magnification, and touch targets too small to activate reliably without accidental triggering of adjacent elements. Think-aloud data and semi-structured interviews consistently confirmed that participants perceived BRImo as functional but effortful. A characterization that the mean SUS score of 84.17 partially obscures, as it reflects satisfaction with the banking service rather than satisfaction with the accessibility of the interface. These findings confirm that inspection-based evaluation alone underrepresents the severity of real-world accessibility barriers, and that the lived experience of both blind and

low-vision users must be incorporated into any meaningful accessibility evaluation of mobile banking applications.

d. Research Question 4: Evidence-based recommendations

The evaluation findings provide the evidential basis for actionable recommendations directed at BRImo developers and designers, presented in Section 5.2 of this chapter. These recommendations are grounded in the convergence of findings across five evaluation instruments and are prioritized according to barrier severity and user impact.

e. Main Research Question: How accessible is BRImo for visually impaired users using TalkBack, and to what extent does it conform to WCAG 2.1 Level AA?

Taken together, the findings across both evaluation phases establish that BRImo is substantially inaccessible for visually impaired users, particularly for totally blind users who depend entirely on TalkBack for navigation. While the application provides a functional banking interface for sighted users, its TalkBack accessibility is inconsistent and unreliable across all seven evaluated features. Core interactive elements are announced without meaningful labels, critical navigation components are rendered unintelligible by the screen reader, and visual design parameters, including contrast and touch target sizing, fall below WCAG 2.1 Level AA thresholds. The WCAG 2.1 conformance assessment confirms this verdict: the majority of applicable success criteria are rated "Supports with Exceptions," indicating widespread partial conformance rather than genuine compliance. Full conformance was achieved on only nine criteria, predominantly those unrelated to accessible labeling or visual design. BRImo, therefore, cannot be considered accessible to WCAG 2.1 Level AA standards in its current form. Addressing the identified barriers through the recommendations presented in this chapter would constitute a substantive and achievable step toward genuine accessibility compliance and meaningful financial inclusion for Indonesia's 8.02 million visually impaired citizens.

## 5.2 Suggestions

a. Recommendations for BRImo Developers and Designers

The following recommendations are directed at PT Bank Rakyat Indonesia (Persero) Tbk development and design teams responsible for BRImo, prioritized by the severity of identified barriers:

1. Label all icon-only interactive elements by adding `contentDescription` attributes to all buttons currently announced only as "Tombol," including fingerprint authentication,

back navigation, notification, balance visibility toggle, and clear field buttons. This is the highest-priority remediation as it affects screen reader users across all seven evaluated features.

2. Correct the QRIS bottom navigation item by adding a visible text label and ensuring TalkBack announces it as "QRIS" rather than an unintelligible technical string, restoring independent access to this core payment feature for blind users.
3. Implement semantic date headers in transaction history by exposing date groupings as programmatically announced headings, enabling screen reader users to determine the chronological context of transactions independently.
4. Improve color contrast across all feature screens to meet WCAG 2.1 Level AA thresholds 4.5:1 for normal text and 3:1 for non-text elements with priority given to the transfer flow and login screen where failures are most severe.
5. Resize all interactive touch targets to a minimum of 48×48dp and maintain at least 8dp spacing between adjacent targets to improve interaction precision for low-vision and motor-impaired users.
6. Convert all text size specifications from dip to sp to enable text to respond to users' system font size preferences in compliance with WCAG 1.4.4.
7. Conduct systematic screen reader testing with TalkBack on each new application release to prevent regression of accessibility improvements and identify new barriers introduced through interface updates.

#### b. Suggestions for Future Research

The following directions are recommended for future research building on the findings of this study:

1. Implement and validate the accessibility recommendations derived from this study through live TalkBack testing of a fully developed native Android application with totally blind participants. This study's evaluation identified specific barriers and provided evidence-based recommendations, but empirical validation of whether those fixes genuinely resolve the barriers for totally blind screen reader users requires implementation in a functional native environment, a step beyond the scope of the current evaluation-focused study.
2. Conduct a larger-scale study with a more diverse participant sample encompassing a wider age range, geographic distribution, and variety of Android devices to enable statistical analysis and improve the generalizability of findings.

3. Extend evaluation to additional BRIimo features beyond the seven core functions evaluated in this study, including the statement feature and authentication flows, to produce a comprehensive accessibility profile of the full application.
4. Conduct cross-platform evaluation by evaluating BRIimo on iOS with VoiceOver, enabling comparative analysis of accessibility behavior across platforms and screen readers.
5. Implement longitudinal evaluation involving participants across multiple testing sessions over an extended period to assess the durability of accessibility improvements and the evolution of compensatory strategies.
6. Extend the accessibility evaluation framework to other Indonesian mobile banking applications to establish comparative accessibility benchmarks for the Indonesian digital financial services sector.

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## APPENDIX

### APPENDIX A PILOT SURVEY INSTRUMENT

#### SECTION 1 — PARTICIPANT DEMOGRAPHICS

Berapa usia Anda? (*How old are you?*)

☐ Di bawah 19 tahun / Under 19

☐ 19–25 tahun / 19–25 years

☐ 26–30 tahun / 26–30 years

☐ Di atas 30 tahun / Above 30 years

Jenis kelamin Anda? (*What is your gender?*)

☐ Laki-laki / Male

☐ Perempuan / Female

☐ Lainnya / Other

Apa tingkat gangguan penglihatan Anda? (*What is your level of visual impairment?*)

☐ Tunanetra total / Totally blind

☐ Low vision (masih memiliki sisa penglihatan / retains partial vision)

Perangkat apa yang Anda gunakan sehari-hari? (*What device do you use daily?*)

☐ Android ☐ iOS (iPhone) ☐ Keduanya / Both

☐ Tidak menggunakan smartphone / Do not use a smartphone

#### SECTION 2 — MOBILE BANKING USAGE

Apakah Anda menggunakan aplikasi mobile banking? (*Do you use mobile banking applications?*)

☐ Ya / Yes → Lanjut ke pertanyaan 6 / Continue to question 6

☐ Tidak / No → Lanjut ke pertanyaan 10 / Continue to question 10

Aplikasi mobile banking apa yang Anda gunakan? (*Which mobile banking applications do you use?*) (*Pilih semua yang berlaku / Select all that apply*)

☐ BRI Mo ☐ BCA Mobile ☐ Livin' by Mandiri ☐ BSI Mobile / Beyond by BSI

☐ Lainnya / Other: \_\_\_\_\_

Seberapa sering Anda menggunakan mobile banking? (*How frequently do you use mobile banking?*)

☐ Setiap hari / Every day ☐ Beberapa kali seminggu / Several times a week

☐ Beberapa kali sebulan / Several times a month ☐ Jarang / Rarely

Fitur mobile banking apa yang paling sering Anda gunakan? (*Which mobile banking features do you use most frequently?*) (Pilih semua yang berlaku / *Select all that apply*)

☐ Cek saldo / Balance checking ☐ Transfer dana / Fund transfer

☐ Top-up pulsa/data / Mobile credit and data top-up

☐ Riwayat transaksi / Transaction history ☐ Top-up e-wallet / E-wallet top-up

☐ Pembayaran QRIS / QRIS payment ☐ Lainnya / Other: \_\_\_\_\_

Apakah Anda menggunakan screen reader (seperti TalkBack) saat menggunakan mobile banking? (*Do you use a screen reader such as TalkBack when using mobile banking?*)

☐ Ya, selalu / Yes, always ☐ Ya, kadang-kadang / Yes, sometimes ☐ Tidak / No

### SECTION 3 — ACCESSIBILITY DIFFICULTIES

(Untuk yang menjawab TIDAK pada pertanyaan 5) Mengapa Anda tidak menggunakan mobile banking? (For those who answered NO to question 5) Why do you not use mobile banking?)

(Untuk yang menjawab YA pada pertanyaan 5) Kesulitan aksesibilitas apa yang Anda alami saat menggunakan mobile banking? (For those who answered YES to question 5) What accessibility difficulties have you experienced when using mobile banking?) (Pilih semua yang berlaku / *Select all that apply*)

Fitur atau kemampuan apa yang Anda inginkan dalam aplikasi mobile banking yang ideal untuk pengguna tunanetra? (What features or capabilities would you want in an ideal mobile banking application for visually impaired users?)

## APPENDIX B Letter of Research Permission

The letter of Research  
permission to Braille 'iant  
Indonesia



FAKULTAS  
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Gedung XII, Mas Mansur  
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Jl. Kalidjeng km 14,5 Yogyakarta 55584  
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Nomor : 128/Kaprodi.IF.S1/20/IF/VII/2025  
Lamp : -  
Hal : Permohonan Penelitian Tugas Akhir

Kepada Yth.  
Pimpinan Braille 'iant Indonesia  
di Gg. Kunta Dewa, RT. 30 RW. 10, Semaki Kulon, Jl. Gayam, Umbulharjo, Yogyakarta

*Assalamu'alaikum Warahmatullahi Wabarokatuh*

Melalui surat ini Program Studi Informatika – Program Sarjana Universitas Islam Indonesia memohon kepada Bapak/Ibu agar dapat mengizinkan mahasiswa kami untuk melaksanakan penelitian Tugas Akhir (TA) di institusi yang Bapak/Ibu pimpin. Pelaksanaan penelitian TA ini merupakan salah satu syarat lulus di program studi kami.

Mahasiswa yang akan melaksanakan penelitian adalah :

Nama : Fatin Maetam  
No. Mhs : 22523310

Kami berharap mahasiswa kami dapat melaksanakan penelitian di institusi Bapak/Ibu antara bulan Juli 2025 sampai dengan Maret 2026. Namun demikian, kepastian jadwal pelaksanaan kami serahkan sepenuhnya kepada institusi Bapak/Ibu.

Demikian permohonan kami, atas perhatian serta terakabulnya permohonan ini kami ucapkan terima kasih.

*Wassalamu'alaykum Warahmatullahi Wabarokatuh*

Yogyakarta, 15 Juli 2025  
Ketua Program Studi Informatika - Program  
Sarjana, Fakultas Teknologi Industri  
  
Dr. Thomas Hatta Fudholi, S.T., M.Eng., Ph.D.

The letter of Reserach  
permission to Ikatan Tunanetra  
Muslim Indonesia



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W. [fti.uii.ac.id](http://fti.uii.ac.id)

Nomor : 194/Kaprodi.IF.S1/20/IF/X/2025  
Lamp : -  
Hal : Permohonan Penelitian Tugas Akhir

Kepada Yth.  
Ketua Ikatan Tunanetra Muslim Indonesia (PW ITMI DIY)  
di PW ITMI DIY gedongkuning rt07 rw02 Kel Rejowinangun Kotagede Yogyakarta

*Assalamu'alaikum Warahmatullahi Wabarokatuh*

Melalui surat ini Program Studi Informatika – Program Sarjana Universitas Islam Indonesia memohon kepada Bapak/Ibu agar dapat mengizinkan mahasiswa kami untuk melaksanakan penelitian Tugas Akhir (TA) di institusi yang Bapak/Ibu pimpin. Pelaksanaan penelitian TA ini merupakan salah satu syarat lulus di program studi kami.

Mahasiswa yang akan melaksanakan penelitian adalah :

Nama : Fatin Maetam  
No. Mhs : 22523310

Kami berharap mahasiswa kami dapat melaksanakan penelitian di institusi Bapak/Ibu antara bulan Oktober 2025 sampai dengan Maret 2026. Namun demikian, kepastian jadwal pelaksanaan kami serahkan sepenuhnya kepada institusi Bapak/Ibu.

Demikian permohonan kami, atas perhatian serta terkabulnya permohonan ini kami ucapkan terima kasih.

*Wassalamu'alaykum Warahmatullahi Wabarokatuh*

Yogyakarta, 3 Oktober 2025  
Ketua Program Studi Informatika - Program  
Sarjana, Fakultas Teknologi Industri  
  
Ir. Dhomas Hatta Fudholi, S.T., M.Eng., Ph.D.

The letter of Reserach  
permission to Bank BRI Kantor  
Cabang (Yogyakarta)



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W. [fti.uii.ac.id](http://fti.uii.ac.id)

Nomor : 233/Kaprodi.IF.S1/20/IF/XI/2025  
Lamp : -  
Hal : Permohonan Penelitian Tugas Akhir

Kepada Yth.  
Pimpinan  
Bank BRI Kantor Cabang (Yogyakarta) Cik DiTiro  
di Jl. Cik Di Tiro No.3, Terban, Kec. Gondokusuman, Kota Yogyakarta, Daerah Istimewa  
Yogyakarta 55121

*Assalamu'alaikum Warahmatullahi Wabarokatuh*

Melalui surat ini Program Studi Informatika – Program Sarjana Universitas Islam Indonesia memohon kepada Bapak/Ibu agar dapat mengizinkan mahasiswa kami untuk melaksanakan penelitian Tugas Akhir (TA) di institusi yang Bapak/Ibu pimpin. Pelaksanaan penelitian TA ini merupakan salah satu syarat lulus di program studi kami.

Mahasiswa yang akan melaksanakan penelitian adalah :

Nama : Fatin Maetam  
No. Mhs : 22523310

Kami berharap mahasiswa kami dapat melaksanakan penelitian di institusi Bapak/Ibu antara bulan November 2025 sampai dengan Maret 2026. Namun demikian, kepastian jadwal pelaksanaan kami serahkan sepenuhnya kepada institusi Bapak/Ibu.

Demikian permohonan kami, atas perhatian serta terakbulnya permohonan ini kami ucapkan terima kasih.

*Wassalamu'alaykum Warahmatullahi Wabarokatuh*

Yogyakarta, 5 November 2025  
Ketua Program Studi Informatika - Program  
Sarjana, Fakultas Teknologi Industri  
  
Ir. Thomas Hatta Fudholi, S.T., M.Eng., Ph.D.