

CONCEPTUAL DESIGN OF AN INCLUSIVE IQRO BRAILLE MODEL BASED ON TACTILE SILICONE ELASTOMER FOR VISUALLY IMPAIRED LEARNERS

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ABSTRACT

This study aims to conceptualize an inclusive Iqro Braille model utilizing tactile silicone elastomer technology to improve Qur'anic literacy, among visually impaired individuals, particularly those with reduced fingertip sensitivity. The study seeks to bridge the technological and ergonomic gaps that limit access to religious education for the blind. A qualitative design using the User-Centered Design (UCD) approach was employed to explore the tactile learning needs of blind learners within the PERTUNI North Sumatra community. Data were collected through semi-structured interviews, focus group discussions (FGDs), and field observations. The collected data were analyzed using the interactive model of Miles, Huberman, and Saldaña (2014) to produce a validated conceptual framework for the Iqro Braille based on tactile silicone elastomer. The findings reveal that most visually impaired learners face difficulty reading conventional Braille due to diminished tactile sensitivity, rigid materials, and limited access to adaptive tools. Participants expressed a strong preference for non-electric, flexible, and portable Qur'anic learning media. The study introduces the conceptual model of Iqronic Braille, integrating three design principles: adaptive tactility, sensory ergonomics, and inclusive accessibility. This model employs a "pop-up" tactile system similar to Pop-It mechanisms, providing improved tactile feedback and comfort for Qur'anic reading. The research focuses on conceptual design rather than prototype testing. Future studies should develop and experimentally validate the prototype to assess tactile effectiveness and user experience. The proposed model can guide the development of inclusive Qur'anic learning media, educational programs, and training modules for teachers and visually impaired learners. It also provides a blueprint for policymakers to standardize adaptive Braille systems in Islamic education. By enhancing access to Qur'anic literacy, this innovation promotes religious inclusion, empowerment, and spiritual independence for visually impaired Muslims. It embodies the principles of ḥifẓ al-dīn (preservation of faith) and taysīr (ease in worship), fulfilling both human rights and Islamic ethical imperatives. This study introduces the first conceptual framework integrating tactile silicone elastomer technology into Iqro Braille design. Unlike previous research that focused on digital or conventional Braille, this model emphasizes non-electronic, ergonomic, and adaptive tactile interaction aligned with Islamic values of inclusivity and accessibility.

Keywords: Iqro Braille, Tactile Silicone Elastomer, Inclusive Education, Visual Impairment, BAZNAS Innovation

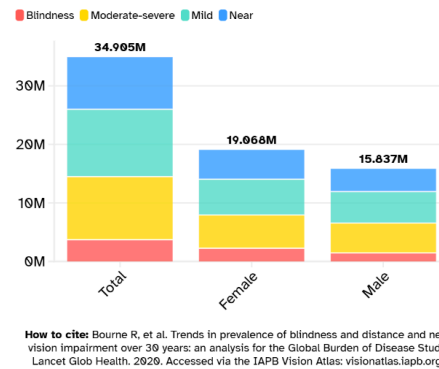
I. INTRODUCTION

The Qur'an serves as the central moral and educational foundation for Muslims. However, access to the Qur'an remains a significant challenge for individuals with visual impairments. Their reliance on tactile and auditory senses limits interaction with traditional Arabic-script mushaf without adaptive media. This reality underscores the pressing need for innovative, inclusive Qur'anic learning systems that are

responsive to the unique sensory requirements of the blind.

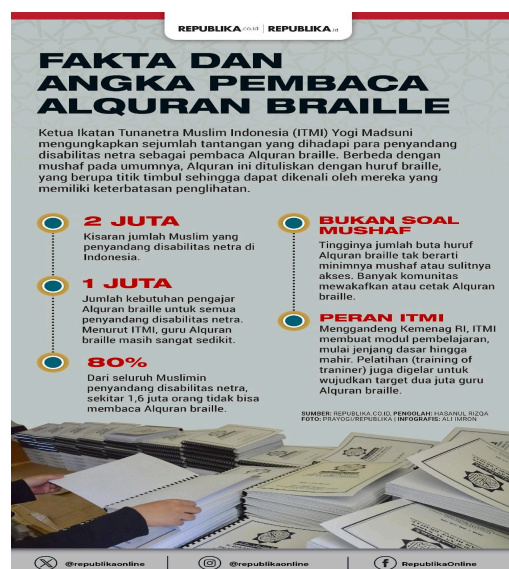
According to the International Agency for the Prevention of Blindness (2023). Indonesia ranks third globally after India and China in the prevalence of visual impairment, with approximately 34.9 million individuals affected, including 3.7 million who are totally blind. National data suggest that nearly 80 % of visually impaired Muslims in Indonesia remain unable to read Braille Qur'an, revealing a substantial gap in religious literacy and equitable access to Islamic education. The relevant data are illustrated in the bar chart below.

Figure 1. Number of People with Vision Impairment in Indonesia (IAPB Vision Atlas, 2025)



Source: IAPB Vision Atlas Country Data Indonesia 2025

Figure 2. Facts and Numbers of Braille Qur'an Readers



Source: Republika Online, 2021 Facts and Numbers Of Braille Qur'an Readers

Field observations at the Indonesian Blind Association (PERTUNI) in North Sumatra indicate that many members, especially those who lost vision later in life, face significant difficulties reading Braille Qur'an due to reduced tactile sensitivity. The small size and rigid texture of conventional Braille dots

hamper effective tactile recognition. Although institutions such as the National Zakat Agency (BAZNAS) and PERTUNI have facilitated Braille Qur'an distribution and organized training, these efforts have yet to address the underlying tactile-sensorial limitations.

To address this technological and ergonomic gap, the present study proposes the conceptual design of an Iqro Braille learning model utilizing tactile silicone elastomer a soft, flexible, and durable material capable of restoring its shape after deformation, providing stable tactile feedback for users with reduced fingertip sensitivity. Drawing inspiration from the tactile mechanism of Pop-It toys, the proposed design enables raised Braille dots to appear and reset dynamically, enhancing tactile perception without requiring external power. Accordingly, this study aims to conceptualize an inclusive Iqro Braille learning framework that leverages silicone elastomer technology to improve tactile sensitivity and promote equitable access to religious education for visually impaired individuals.

II. LITERATURE REVIEW

2.1 CRPD and Inclusive Rights

The Convention on the Rights of Persons with Disabilities (CRPD) establishes the international legal framework ensuring the full realization of human rights and fundamental freedoms for persons with disabilities (Degener, 2017). Adopted by the United Nations General Assembly on 13 December 2006 through Resolution A/RES/61/106 and entering into force on 3 May 2008, the CRPD represents a global shift from a welfare-based to a rights-based approach to disability (Mladenov, 2013).

Article 24 of the CRPD emphasizes the right to inclusive education, guaranteeing that individuals with disabilities including those with visual impairments receive education without discrimination and on the basis of equal opportunity. This article explicitly calls for accessible formats such as Braille, audio, screen readers, and multisensory learning materials, along with teacher training in inclusive pedagogy.

However, as (Mladenov, 2013). critically points out, the interpretation of disability rights is shaped not only by legal obligations but also by socio-political realities. Access to inclusive education often depends on how local systems implement adaptive technology and training. In Indonesia, the government ratified the CRPD on 30 March 2007 in New York and reinforced it through Law No. 20 of 2003 on the National Education System (Sisdiknas), which ensures that every citizen including those with disabilities has the right to quality education (Novrizal & Manaf, 2024). This law explicitly mandates the organization of inclusive or special education for students with disabilities. Therefore, the CRPD and Indonesia's legal framework jointly affirm that providing inclusive access to education, particularly Qur'anic education for the blind, is both a national duty and a human right.

2.2 Challenges In Qur'anic Braille Literacy

The Qur'an Braille serves as the primary medium enabling visually impaired Muslims to access the sacred text. Its presence has significantly contributed to religious education inclusion. Nevertheless, empirical studies reveal persistent obstacles technical, pedagogical, and infrastructural.

Hamzah & Zaenal, (2018) highlight the need for innovation in Qur'anic Braille design, proposing the concept of Qur'anic Technobraille to simplify reading and learning processes. Similarly, Yanti & Kunci, (2025) identify structural barriers such as high production costs, limited distribution, and the scarcity of qualified Braille and Tajwid instructors. Widiarti, (2019) compares printed and digital Braille Qur'ans, finding that although printed Braille remains more familiar, digital versions provide greater

accessibility and portability. However, technological limitations still hinder widespread adoption among blind learners.

Furthermore, Muhyi et al., (2023) demonstrate that Braille Qur'an education in special schools requires adaptive teaching strategies and practical guidance to facilitate the learning of Hijaiyah letters. Pebriandi (2021) also reports that digital Braille Qur'ans, such as those used at the Raudlatul Makfufin Foundation, enhance memorization efficiency through audio-text synchronization, yet tactile Braille remains essential for maintaining literacy skills.

Taken together, these studies reveal that Qur'anic Braille remains an indispensable medium for Islamic literacy among the blind, but significant challenges persist in affordability, distribution, instructional training, and tactile usability particularly among adults who lose vision later in life and have reduced fingertip sensitivity. However, none of the existing studies have addressed tactile ergonomic design innovations that can enhance Braille sensitivity without relying on digital energy sources an area where the present study contributes.

2.3 Islamic Perspective on Knowledge and Technological Innovation

From an Islamic epistemological standpoint, 'ilm (knowledge) holds a central role in guiding humanity toward righteousness, wisdom, and societal benefit. The Qur'an emphasizes this principle in Surah Az-Zumar (39:9): "Say, 'Are those who know equal to those who do not know?' Indeed, only those who possess understanding will take heed."

This verse underscores the sanctity of knowledge as both a moral distinction and a means to achieve collective welfare. Consequently, the pursuit of science and technological innovation in Islam must align with ethical and spiritual objectives (maqāṣid al-sharī'ah), ensuring that progress serves the broader interests of the ummah rather than mere individual benefit.

The development of an Iqro Braille model based on tactile silicone elastomer reflects the principle of ḥifz al-dīn (preservation of religion), ensuring that technological innovation strengthens faith and facilitates access to Qur'anic understanding (Harefa & History, 2025). The concept also embodies taysīr (ease in worship), as Islamic jurisprudence states: al-mashaqqah tajlib al-taysīr "difficulty brings ease." Thus, innovations that make religious practice accessible for persons with disabilities represent the spirit of mercy and inclusivity inherent in Islamic law (Hariyanto et al., 2021).

Moreover, Islamic ethics demand ta'zīm al-Qur'an respect for the sanctity and integrity of the Qur'anic text. Any material used for Qur'anic transcription, including elastomer-based surfaces, must maintain purity, durability, and reverence toward the sacred word (Singh, 2024). Within Uṣūl al-Fiqh, the principle of ibāḥah al-ibtikār (permissibility of innovation) asserts that innovation is allowed so long as it does not contradict divine law and leads to tangible benefits (maṣlaḥah) without harm (mafsadah) (Ziadul Ulum Wahid et al., 2025). Consequently, the use of tactile silicone elastomer for Qur'anic Braille can be viewed as a bid'ah ḥasanah (beneficial innovation) that upholds inclusivity ('adl wa syumūl) and ensures equitable access to religious learning for all believers, including those with visual impairments.

2.4 Previous Studies and Research Gap

Recent studies in Indonesia (2022–2024) have focused on enhancing Qur'anic accessibility for the visually impaired through both Braille and digital media. For instance, a study at SLB Negeri Branjang Jember reported that the integration of digital Braille with audio recitation significantly improved memorization accuracy among blind students. Similarly, a study conducted at UIN Jakarta emphasized the

need for standardized Braille Hijaiyah characters to improve readability across national printeditions.

The 2024 report by Indonesia's Ministry of Religious Affairs further demonstrates government support for inclusive Qur'anic services, including Braille and sign-language versions of the Qur'an. Additional studies have explored multisensory tahfizh methods combining tactile Braille with auditory recitation, proving more effective than conventional approaches.

Despite these advancements, a research gap remains regarding the tactile-ergonomic optimization of Qur'anic Braille for individuals with diminished fingertip sensitivity especially those who acquired blindness through illness or accident. The proposed *Iqro Braille Model based on Tactile Silicone Elastomer* aims to fill this gap by introducing an adaptive tactile surface capable of dynamically adjusting Braille dot height through elastomeric flexibility, thereby enhancing sensory feedback and reading comfort without relying on electronic power sources.

Thus, this study positions itself at the intersection of Islamic education, assistive tactile technology, and disability inclusion, offering both a conceptual and technological contribution toward accessible Qur'anic learning.

III. METHODOLOGY

This study employed a qualitative research design using a user-centered design (UCD) approach, focusing on the development of a conceptual framework for the *Iqro Braille Model based on Tactile Silicone Elastomer* as an inclusive Qur'anic learning medium for persons with visual impairments.

The qualitative design was chosen to capture user needs, contextual experiences, and sensory challenges in Qur'anic learning among blind learners, while the UCD approach ensured that the conceptual model was grounded in the lived experiences and tactile perceptions of its intended users. Rather than producing a physical prototype, this study emphasizes the conceptual and ergonomic design phase, which forms the foundation for subsequent prototyping research.

3.1 Research Object

The research was conducted within the context of the Indonesian Blind Association (PERTUNI) North Sumatra, which serves as a learning and advocacy community for persons with visual impairments. Participants were selected using purposive sampling, including (1) adult blind learners, (2) organizational leaders, and (3) inclusive education experts familiar with Braille Qur'an instruction.

The object of this research was the conceptual framework of the *Iqro Braille Model*, designed using tactile silicone elastomer material to simulate raised Braille dots that can be pressed and return to their original form mimicking the tactile dynamics of Pop-It educational tools. This model aims to enhance tactile sensitivity among individuals with reduced fingertip perception due to acquired blindness in adulthood.

3.2 Research Procedures

This study employed a qualitative research design following a user-centered design (UCD) approach. The research procedure consisted of four main stages, as described below.

1. Need Identification

An in-depth interview was conducted with members of the Indonesian Blind Association (PERTUNI) North Sumatra to explore their experiences in learning the Qur'an, difficulties in reading conventional Braille, and expectations for a more tactile-responsive Qur'anic learning medium. This stage aimed to capture users' sensory preferences and barriers to tactile literacy.

2. Focus Group Discussion (FGD)

A series of FGD were organized with community leaders and visually impaired participants from PERTUNI to discuss potential features, content, and design principles of the proposed Iqro Braille learning medium based on tactile silicone elastomer. This process allowed participants to co-design and validate conceptual elements of inclusivity, comfort, and usability.

3. Data Analysis

The collected data were analyzed using the interactive model of Miles, Huberman, and Saldaa (2014), consisting of data reduction, data display, and conclusion drawing/verification. Thematic coding was applied to identify recurring patterns related to tactile perception and user learning needs.

4. Conceptual Framework Development.

The final stage synthesized the results of interviews and FGDs into a conceptual framework outlining the system components, Braille dot mechanism, feature structure, and inclusive pedagogical principles of the tactile silicone elastomer based Iqro Braille model.

Figure 3. Roadmap of The Iqro Braille Model Based on Tactile Silicone Elastomer



Source: Author's Documentation, 2025

3.3 Data Collection Techniques

Data were collected through semi-structured interviews and focus group discussions (FGDs) conducted between September and November 2025. The semi-structured interviews explored participants' experiences in reading Braille Qur'an, challenges in tactile recognition, and expectations for adaptive learning media.

The FGD sessions, attended by PERTUNI Sumut board members and visually impaired

participants, focused on discussing design features, usability principles, and inclusive content structure for the proposed Iqro Braille Model.

Field notes and reflective memos were also recorded to capture non-verbal cues and contextual insights. To ensure data triangulation, findings were cross-validated across interviews, FGD outcomes, and expert reviews in inclusive education.

3.4 Data Analysis

Data analysis followed the interactive model of Miles, Huberman, and Saldaña (2014), which involves three cyclical steps data condensation, data display, and conclusion drawing/verification. Data were coded through open, axial, and selective coding, allowing themes to emerge inductively from participants' narratives. Codes related to tactile interaction, sensory comfort, and accessibility features were synthesized to form thematic clusters that informed the design principles of the conceptual framework. Analysis and data collection were conducted concurrently to refine interpretations iteratively, ensuring analytical depth and credibility.

3.5 Expected Output

The expected outcome of this study is a validated conceptual framework of the Iqro Braille Model based on Tactile Silicone Elastomer, comprising key system components, tactile mechanisms, tactile prototype, feature design, content elements, inclusive pedagogical principles, and user interaction pathways. This framework serves as a theoretical foundation for future prototyping and experimental implementation of inclusive Iqro Braille Model based on Tactile Silicone Elastomer.

3.6 Result

The methodology section should describe the data, model development, and methods employed, along with the scientific rationale for their selection. Papers may be either quantitative or qualitative. For quantitative studies, simple and nonessential equations may be written within the text (e.g., $a = b/c$), while important equations should be displayed on a separate line. Principal equations must be numbered consecutively, with the number placed in parentheses and right-aligned. Authors are strongly advised to use MS Word Equation Editor or MathType when preparing both inline and display equations. Equations form part of the sentence and should therefore include appropriate punctuation. To apply the correct formatting, select the 'Equation' style, which sets the tab stop position. Press the tab key once to position the equation and once more to insert the equation number on the right.

IV. RESULTS AND DISCUSSION

4.1 Research Finding

The researcher identified the research subjects and case study within the PERTUNI (Indonesian Blind Association) community of North Sumatra using a purposive sampling technique. The study involved seven totally blind participants, consisting of two experts in inclusive education for the visually impaired and five active members of the PERTUNI North Sumatra community. All participants were active users

of the Braille Qur'an, aged between 40 and 60 years, and were capable of understanding the context of Qur'anic learning for individuals with visual disabilities.

Based on the initial findings, most participants experienced difficulties in reading conventional Iqro Braille due to frequent sweating of the hands, which caused Braille dots to wear out, fade, or become difficult to distinguish by touch. In addition, participants reported that the Braille dots' size being too fine and small posed sensory challenges in differentiating letter characters. Consequently, the research focus was specifically directed from the outset toward developing a conceptual framework for an Iqro Braille medium based on tactile silicone elastomer, designed to meet the real needs of users within the PERTUNI North Sumatra community.

Table 1. (Demographic Characteristic of Research Participants)

Participant Code	Gender	Age	Type of Visual Impairment
P01	Male	37	Total blind
P02	Female	30	Total blind
P03	Female	73	Total blind
P04	Female	51	Total blind
P05	Male	33	Total blind
P06	Female	50	Total blind
P07	Female	58	Total blind

Source: Primary data obtained from field research (Pertuni Nort Sumatera Community,2025)

1. Need Identification

Based on the results of the needs identification conducted by the researcher through in-depth interviews and field observations with seven members of the North Sumatra Blind Union (PERTUNI), the study obtained qualitative data that captured the participants' learning experiences, challenges, and the need for more accessible learning media for individuals with visual impairments. The findings from the interviews and field notes are categorized and presented under three main themes as follows.

2. Learning Experiences

The interviews revealed that the process of learning Qur'anic Braille follows distinctive stages and challenges that differ considerably from conventional Qur'anic learning among sighted individuals. Most participants stated that Braille Qur'an learning typically begins in adulthood through non-formal educational settings, rather than during childhood. This is because learners must first master Latin Braille literacy before advancing to Arabic Braille, which serves as the foundation for reading the Qur'an. Consequently, Qur'anic Braille proficiency becomes an advanced literacy skill requiring prior mastery of the tactile dot system.

Participants described the initial stages of Qur'anic Braille learning as highly challenging. They often experienced difficulty distinguishing small Braille dots, especially as age and fingertip sensitivity decreased. Several respondents admitted frequent misreading due to worn or flattened Braille paper, making tactile differentiation more difficult.

The learning process generally starts with Latin Braille letters and punctuation, followed by Iqro Braille, and eventually the Braille Qur'an. The Iqro Braille version used within the Pertuni community has been simplified and adapted to meet the needs of blind learners. It contains approximately 50 pages of

exercises on fathah, kasrah, and dhammah reading practices. Learning activities are conducted biweekly on Thursdays in a group setting at Pertuni, serving not only as an educational forum but also as a social and spiritual space for members.

Some participants mentioned using digital tools as supplementary resources, such as talking Qur'an pens or audio Qur'an applications, though these are primarily designed for listening rather than active reading. Due to time and access constraints, several respondents preferred listening to Qur'anic recitations via YouTube instead of engaging in guided study.

In summary, the learning experiences of Pertuni North Sumatra members reflect a combination of self-directed learning, community support, and adaptation to modern technology. Their learning emphasizes gradual tactile skill development, recognition of Arabic Braille symbols, and adaptation to physical and resource limitations

3. Learning Barriers

The findings indicate that Qur'anic Braille learning among the visually impaired is constrained by various physical, technical, and psychosocial barriers that significantly affect learning effectiveness. These barriers are classified into three main categories: (a) sensory-physical barriers, (b) technical and material barriers, and (c) psychosocial and environmental barriers.

A. Sensory Physical Barriers

Most participants reported reduced finger sensitivity due to factors such as age, dry skin, or health conditions (e.g., neuropathy). This reduction in tactile perception made it difficult to feel Braille dots, particularly when the paper surface became worn or flattened. Some participants also experienced finger fatigue during prolonged reading sessions, which limited study time. Such physical challenges directly affected reading speed and accuracy, especially with complex Arabic symbols and diacritical marks.

B. Technical and Material Barriers

Technical issues primarily involved the quality and durability of Braille materials. Several Qur'an Braille pages were inconsistent in embossing, with dots that were either too shallow or worn out from repeated use, reducing motivation to learn. Participants also reported limited access to high-quality Braille tools and materials, as Braille paper and writing machines (Braille writers) are expensive. Many relied on shared or borrowed materials from the community. The absence of adaptive technology, such as digital Braille or audio-based training applications, further constrained independent learning.

C. Psychosocial and Environmental Barriers

Non-physical obstacles included psychological fatigue, frustration, and decreased motivation resulting from slow learning progress and difficulty differentiating similar Braille characters. Time constraints were another major issue, as most participants were adults balancing work and family responsibilities. Although lighting is not a critical factor for blind learners, noisy or uncomfortable environments were reported to disrupt concentration during tactile reading.

D. Need for Media Innovation and Adaptation

While participants had experimented with digital Qur'an pens or audio Qur'an apps, they noted that such tools mainly serve listening purposes, not active reading. Therefore, participants

expressed a strong need for innovative, tactile-based media that enable flexible and efficient Qur'anic reading according to their tactile sensitivity and sensory conditions.

4. Learning Media Needs

Interviews with the seven Pertuni respondents revealed highly specific needs for Qur'anic Braille learning media that are adaptive, portable, and tactile-sensitive. Participants had varying degrees of blindness—some congenital, others acquired—resulting in differing finger sensitivity levels. These findings became the empirical foundation for designing the Tactile Silicone Elastomer–Based Iqro Braille Innovation.

A. Non Electrical Operation

Approximately 85% of participants emphasized the importance of non-electric, battery-free learning devices. They explained that Qur'anic study often occurs in community centers, mosques, or rural homes without reliable electricity. Moreover, participants felt that electronic devices may diminish the spiritual simplicity of Qur'an study. Hence, a mechanically operated tactile medium made from silicone elastomer was considered the most appropriate solution.

B. Portability and Comfortable Size

All participants valued portability and preferred a lightweight, compact device suitable for both individual and group study. The ideal size was comparable to a standard Iqro book (A5) and weighed no more than one kilogram. The flexible and durable properties of silicone elastomer were seen as ideal for long-term tactile use.

C. Adjustable Braille Dot Configuration

Five of the seven participants stressed the need for adjustable Braille dot thickness and spacing, as tactile sensitivity varies across individuals—especially among those who lost vision later in life. Conventional flat Braille dots were described as difficult to distinguish, while a mechanically adjustable tactile surface would allow users to better perceive letter forms.

D. Interface and Control Design

Most participants preferred simple physical interactions (e.g., pressable or magnetic slider buttons) rather than touchscreen interfaces. They perceived mechanical systems as more intuitive and user-friendly. A “Pop-It Toy”-like mechanism—where dots can be pressed and reemerge—was considered engaging and effective for tactile reading practice.

E. Audio Feedback Requirement

About 60% of participants highlighted the need for minimal audio feedback, such as a *click* or *short beep* indicating Braille activation. This feedback helps confirm tactile input without interrupting concentration. However, participants agreed that audio should remain optional to preserve the calm atmosphere of Qur'an recitation.

F. Compatibility with Hijaiyah Letters and Tajweed Marks

All respondents emphasized that the new Braille system must be compatible with Arabic Hijaiyah characters and Tajweed symbols, not merely standard Arabic Braille. They cited the lack of clear Tajweed markers as a major limitation in existing Braille Qur'an materials. The tactile silicone elastomer Braille system is therefore expected to represent complete Hijaiyah structures alongside reading and pronunciation signs.

G. Reading to Learning Using Media

Around 70% of respondents expressed readiness to learn and adapt to the new tactile media, provided simple instructions or short training sessions are available. They viewed intuitive and

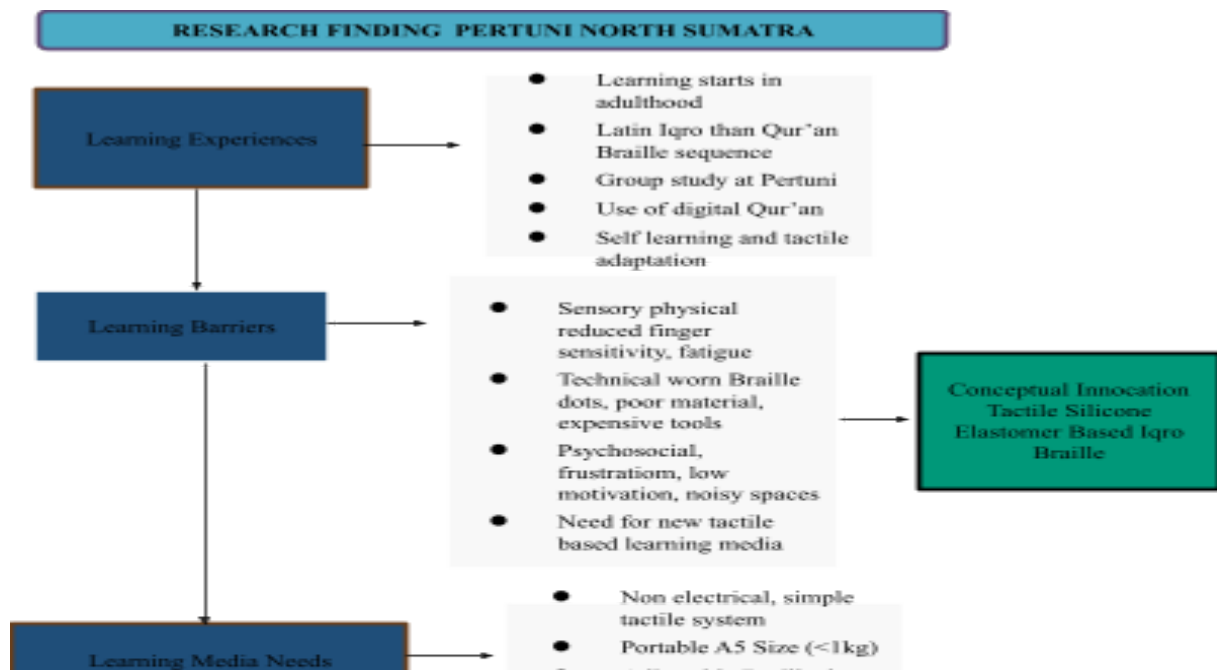
accessible design as key to reducing adaptation challenges, reflecting strong motivation for religious and educational empowerment.

H. Expected Benefits

All participants expressed high expectations that the innovative Iqro Braille media would enhance their independence and spiritual engagement in Qur'anic learning. They hoped that the Tactile Silicone Elastomer Iqro Braille would not only serve as a reading aid, but also as a medium of empowerment and spiritual enrichment. One respondent noted that with a more sensitive and comfortable tactile interface, they could once again experience a deeper, more meaningful connection while reading the Qur'an.

Through this in-depth qualitative analysis, the researcher mapped out the learning experiences, barriers, and needs of visually impaired learners in the PERTUNI North Sumatra community. This needs map provides a comprehensive understanding of the cognitive, affective, social, and accessibility dimensions that influence Qur'anic literacy among blind individuals. The Needs Identification Map of the Pertuni community is presented in Figure 4.

Figure 4. Research Finding Learning Experiences, Barriers and Media Needs of The Qur'an Braille Learners in North Sumatera



Source: Author's Documentation, 2025

4.2 Focus Group Discussion (FGD) Findings at PERTUNI North Sumatra

The Focus Group Discussion (FGD) was conducted after the researcher completed the needs identification phase through in-depth interviews and field observations with members of the Indonesian Blind Association (PERTUNI) North Sumatra, teachers assisting visually impaired students, educational technology media developers, and representatives from Islamic educational and religious institutions. The purpose of this FGD was to obtain comprehensive input for designing an inclusive learning medium to be developed by the researcher. The FGD was divided into three sessions consisting of presentations and guided discussions on the following themes: (1) feature proposals, (2) content proposals, and (3) design principles.



Figure 5. Focus Group Discussion (FGD)



Figure 6. Focus Group Discussion (FGD)



Figure 7. Focus Group Discussion (FGD)**Figure 8.** Focus Group Discussion (FGD)

A. Tabulation of Proposed Solutions for the Development of Braille Iqro Media Based on Silicone Elastomer Tactile Technology

The third phase of this research involves the preparation of a prioritized tabulation of solutions derived from a Focus Group Discussion (FGD) with members of the PERTUNI North Sumatra community. This activity focuses on proposed features, content, and design principles for a Braille Iqro media developed using flexible silicone elastomer tactile technology.

Table 2. (Result of Focus Group Discussion FGD)

No .	Discussion Aspect	Key Issues	Proposed Solutions and Recommendations
1	Feature Proposal: Braille Dot Shape and Texture	Conventional Braille dots are too flat and wear out quickly, making them difficult for users' fingers to perceive.	Design raised (pop-up) Braille dots similar to a "pop-it" model, sized approximately like a bead to facilitate easy touch without causing discomfort. Each dot corresponds to a single finger, with proportional height adjusted to the tactile sensitivity of visually impaired users.
2	Feature Proposal: Interactive Mechanism	Conventional Braille is passive and does not provide feedback to the user.	Develop a tactile-press system: when a dot is pressed, the media produces the corresponding letter or phonetic sound via a simple device connection (optional, without internal electricity). This audio feature functions as a verification tool for reading accuracy (Qur'an recitation check).
3	Feature Proposal: Media Material	Braille paper tears easily and generates rough friction on the fingers.	Utilize soft, elastic silicone elastomer that is smooth, non-abrasive, non-sharp, yet solid and tangible. The material resembles soft rubber, remains stable under touch, and requires no electricity, making it suitable for religious contexts.
4	Content Proposal: Braille Iqro Structure	Conventional Braille Iqro content can be difficult for beginners to understand due to dense	Arrange content with wider, proportional spacing between dots and letters to enhance finger comfort. Content adheres to standard Braille Iqro, but incorporates pop-it style design to facilitate tactile exploration.

		formatting and tightly spaced dots.	
5	Content Proposal: Accompanying Audio Integration	Beginners need audio guidance to ensure correct pronunciation of Hijaiyah letters.	Include an audio accompaniment feature that can connect to smartphones or laptops to play pronunciations of Hijaiyah letters and short verses, strengthening a multisensory learning process.
6	Design Principle: User Ergonomics and Comfort	Conventional Braille often causes finger fatigue due to narrow line spacing.	Adjust interline and interletter spacing to be more spacious than conventional Braille. Design as a flexible pop-it panel that is lightweight, portable, and easy to clean.
7	Design Principle: Media Safety and Hygiene	Paper-based Braille is easily soiled or damaged when used in places of worship or humid environments.	Use hygienic, water-resistant silicone material that is easily washable without damaging the Braille dots. Designed for long-term use in mosques, schools, or homes.
8	Design Principle: Pedagogical Engagement and Inclusivity	Teachers and users lack specific guidance on reading and teaching with elastomer-based media.	Develop a user manual and teacher training module explaining how to read, write, and maintain the elastomer Braille Iqro. The guide includes Braille dot standards and usage examples for Qur'an learning activities.

4.3 Data Analysis

The data analysis in this study followed the interactive model of Miles, Huberman, and Saldaña (2014), which consists of three cyclical stages: data condensation, data display, and conclusion drawing and verification. The analysis process was conducted concurrently with data collection, allowing iterative refinement of meaning and validation of findings throughout the study.

4.4 Data Condensation

This stage began during data collection through field observations, in-depth interviews, and Focus Group Discussions (FGDs) with members of the PERTUNI (Indonesian Blind Association) North Sumatra community. All interview transcripts and field notes were repeatedly reviewed to select information relevant to the research focus namely, the participants' learning experiences, sensory challenges, and the need for a more adaptive Braille Qur'an learning medium.

The data were then coded using three stages of coding:

- Open coding: identifying words or phrases that represent tactile learning experiences and perceptions of existing Braille media.
- Axial coding: grouping codes into broader categories such as tactile interaction, sensory comfort, media adaptation, and learning accessibility.

- Selective coding: integrating categories to identify the central theme—the need for a responsive, flexible, and portable Iqro Braille medium based on Tactile Silicone Elastomer.

Through this process, the initially scattered qualitative data were condensed into four main thematic clusters:

1. Tactile Interaction and Finger Sensitivity
2. Physical Barriers and Limitations of Conventional Braille Materials
3. Need for Portable and Non-Electric Media Design
4. Preference for Audio Features and User Ergonomics

4.5 Data Display

The condensed data were then organized into thematic tables, comparative matrices, and conceptual maps for instance, the coding results showed that the theme “tactile interaction” appeared seven times across interviews and was reconfirmed during the FGD sessions, while “media portability” emerged as the most frequently mentioned aspect, highlighted by approximately 85% of participants. This display revealed clear patterns between sensory experience and media design, emphasizing that the tactile dimension is central to learning effectiveness among blind learners.

Furthermore, the displayed data demonstrated consistency and triangulation across sources:

- From observations, most participants were found to experience difficulty reading Braille dots due to sweaty hands.
- From interviews, a strong preference emerged for more elastic materials that would not wear out quickly.
- From the FGD, participants collectively recommended the use of silicone elastomer materials featuring *pop-up tactile dots*.

These converging insights confirmed the validity and coherence of the themes that guided the conceptual framework design.

4.6 Conclusion Drawing and Verification

In the final stage, conclusions were drawn by examining interrelationships among the established themes. The analysis revealed that the primary needs of blind learners include non-electric, tactile, portable, and flexible learning media, complemented by an optional audio feedback system to assist in pronouncing Arabic letters correctly.

To ensure analytical credibility, the emerging conclusions were validated through a member-checking process with FGD participants and inclusive education experts. This process confirmed the accuracy and contextual relevance of the interpretations. The final results of this data analysis formed the foundation for developing the conceptual framework of the *Iqro Braille Medium based on Tactile Silicone Elastomer*, integrating three key design principles:

1. Adaptive Tactility: Braille dots can be pressed and re-emerge naturally, supporting tactile engagement.
2. Sensory Ergonomics: Silicone elastomer provides soft and comfortable tactile feedback suited to varying finger sensitivities.

3. Inclusive Accessibility: Enables independent Qur'anic learning without reliance on electrical power sources.

The conceptual framework developed in this study was constructed based on the results of data condensation, display, and verification obtained through field observations, in-depth interviews, and Focus Group Discussions (FGDs) with members of the PERTUNI (Indonesian Blind Association) North Sumatra community. The analytical process followed the interactive model of Miles, Huberman, and Saldaña (2014), which was conducted cyclically and concurrently with data collection to ensure iterative refinement and analytical credibility.

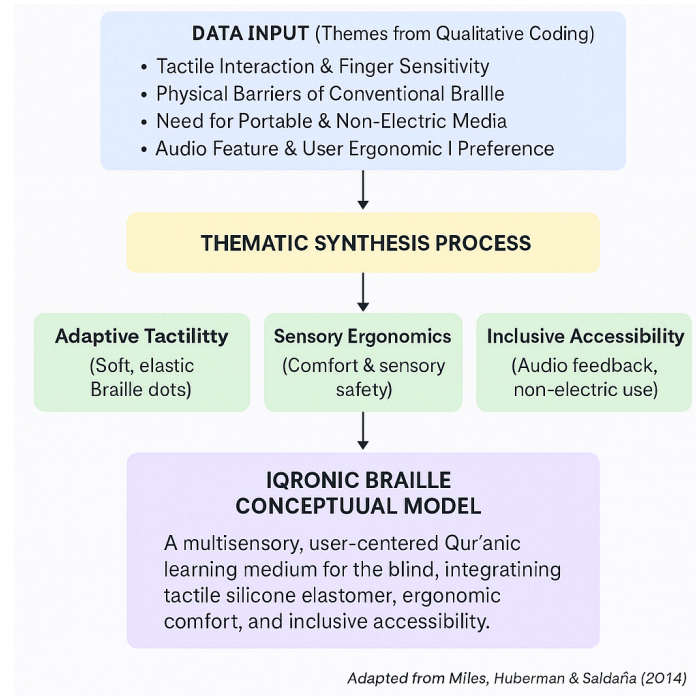
During the data condensation phase, open, axial, and selective coding were performed to extract and categorize key themes relevant to Qur'anic learning among visually impaired participants.

The analysis yielded three core themes, namely:

1. The need for adaptive tactile interaction, reflecting the importance of responsive touch experiences that accommodate varying finger sensitivities of Braille users;
2. Sensory comfort in Braille reading, emphasizing the ergonomic and material safety aspects that enhance reading efficiency and reduce fatigue; and
3. The importance of interactive audio feedback, which supports independent learning and enables verification of Qur'anic recitation accuracy.

These three themes were then synthesized into the conceptual model of Iqronic Braille based on Tactile Silicone Elastomer, integrating the principles of adaptive tactility, sensory ergonomics, and inclusive accessibility. This synthesized framework is visualized in Figure 9, illustrating the integration between empirical findings and the theoretical foundation that underpins the design of an inclusive Qur'anic learning medium for the visually impaired.

Figure 9. Conceptual Model of Iqro Braille Based on Tctile Silicone Elastomer



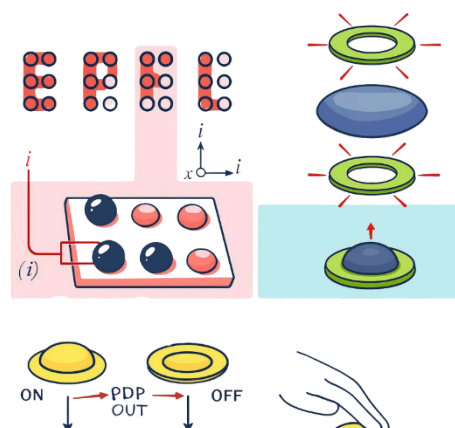
Source: Author's Documentation, 2025

The conceptual model (as visually represented in Figure 7) was developed based on the thematic synthesis of qualitative data analyzed using the interactive model of Miles, Huberman, and Saldaña (2014). Four major themes tactile interaction, sensory barriers, portability, and audio ergonomics were condensed and integrated into three principal design components: Adaptive Tactility, Sensory Ergonomics, and Inclusive Accessibility. These components form the foundation of the Iqronic Braille conceptual framework, representing a user-centered and multisensory learning system for visually impaired Qur'anic learners.

Following the conceptual synthesis derived from Miles, Huberman, and Saldaña's (2014) interactive model, an early tactile prototype of the Iqronic Braille system was developed. This prototype employs an elastic silicone elastomer dome system with a pop-up tactile mechanism, leveraging the intrinsic elasticity of silicone to provide an adaptive, comfortable, and durable tactile reading experience for visually impaired users. The design translates the conceptual principles of Adaptive Tactility, Sensory Ergonomics, and Inclusive Accessibility into a functional mechanical interface.

The prototype is structured into four stages, each representing a key functional aspect of the tactile interaction system. These stages are illustrated in Figure 10, highlighting how the conceptual framework has been operationalized into a tangible design.

Figure 10. Prototype Development Stages of The Iqro Braille Based n Tactile Elastomer



Source: Author's Documentation, 2025

As illustrated in Figure 8, each stage of the Iqronic Braille prototype embodies a key principle of the conceptual framework. The design ensures an adaptive, comfortable, and durable tactile experience that aligns with the core components of Adaptive Tactility, Sensory Ergonomics, and Inclusive Accessibility. This visual representation bridges the conceptual model with its practical implementation, providing a clear foundation for the development of the Iqronic Braille learning media.

V. CONCLUSION AND RECOMMENDATION

This study concludes that the tactile limitations of conventional Braille Qur'an materials hinder Qur'anic literacy among visually impaired Muslims, especially adults with reduced fingertip sensitivity. Using a user-centered qualitative approach with the PERTUNI North Sumatra community, this research developed a conceptual framework for an inclusive *Iqro Braille* model based on tactile silicone elastomer technology, emphasizing adaptive tactility, sensory ergonomics, and inclusive accessibility. The findings highlight that a flexible and durable silicone medium can enhance tactile perception and spiritual engagement in Qur'anic learning.

Therefore, it is recommended that the National Zakat Agency (BAZNAS) collaborate with PERTUNI and Islamic education institutions to develop, test, and distribute the *Iqro Braille Berbasis Tactile Elastomer Silikon* as part of the *Zakat for Inclusive Islamic Education* initiative. This innovation should also be adopted by policymakers as a national model for inclusive Qur'anic education, aligning with the principles of the CRPD. Through this effort, BAZNAS can pioneer faith-based technological inclusion that upholds *ḥifẓ al-dīn*, *taysīr*, and *'adl wa syumūl* for persons with visual impairments.

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