Braille Identification Tool to Assist Companions of Blind Individuals

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ABSTRACT
In 2017, Indonesia ranked second globally in the number of visually impaired individuals, leading to high dependency on assistance due to a lack of supportive facilities. Existing solutions, like sighted companions labeling items, do not fully address this issue. Ability-based design, leveraging enhanced tactile and auditory senses, can foster greater independence. This research uses the Research through Design (RtD) methodology, involving iterative design, prototyping, and testing cycles. RtD is ideal for refining ideas through continuous improvement, fostering collaboration, and translating theories into practical solutions. The study developed a handheld, portable label maker that prints Braille characters on labels for various surfaces, aiming to reduce dependency on companions. This tool facilitates the daily lives of both visually impaired individuals and their companions. The design process's iterative nature ensured a practical and effective solution. In conclusion, this study provides insights into designing a Braille label maker to assist visually impaired individuals and their companions. User reviews confirm that the labeling process significantly enhances daily efficiency. The ability-based design approach successfully meets its objectives, highlighting its importance in creating effective solutions for the visually impaired.

Keywords: Blind, Braille, Ability-Based Design, Braille Label

INTRODUCTION
According to the Indonesian Ministry of Health in 2017, Indonesia ranks second globally in vision impairments, affecting 3.75 million people, with 40% being children and teenagers aged 6-18. While the Braille alphabet aids reading, existing Braille signage primarily supports mobility in public spaces, neglecting household needs. Companions of visually impaired individuals face unique challenges at home, such as assisting with cooking, selecting outfits, and organizing medications, which require precise accessibility solutions to enhance independence. The proposed Braille labeling system aims to empower companions by enabling them to create and apply Braille labels on various household items like spices, clothing, and medications. This enhances the autonomy and self-sufficiency of visually impaired

individuals. The expected outcome is a significant reduction in dependency on companions for everyday tasks, promoting greater independence and quality of life. This initiative aligns with ability-based design principles, leveraging the strengths of companions to facilitate accessibility and inclusivity in household environments.

The prevalence of vision impairments highlights the need for personalized solutions that empower companions. By developing the proposed Braille labeling system, companions can promote independence and enhance the well-being of visually impaired individuals.

LITERATURE REVIEW

Blind and Visually Impaired

According to the Kamus Besar Bahasa Indonesia, “tuna” means wounded or lacking, and “netra” refers to eyes or sight. Combined, “tunanetra” signifies eye impairment or damage, hindering the individual’s ability to receive visual information. Expanding on this, Somantri (2012) defines visually impaired individuals as those whose sight does not function adequately to receive information like the general populace, necessitating alternative means to access information and engage with their environment.

The Indonesian Blind Union (Pertuni) further explains that visual impairment ranges from total blindness to residual vision, where even those with some sight may struggle to read standard-sized text under typical lighting conditions despite corrective tools. Thus, “visually impaired” encompasses conditions from total blindness to limited vision, all marked by an inability to rely on sight for daily tasks, highlighting the complexity and diversity of experiences within this community.

Braille

Braille is a writing system comprising arrangements of one to six raised dots in each character, serving as the fundamental communication system for reading and writing among the visually impaired. There are several methods for writing Braille: manual writing involves the use of a riglet and stylus, while assisted writing utilizes Braille typewriters. Braille writing finds utility in educational materials, data recording, entertainment, and various other printed information formats. It encompasses alphabetic letters, punctuation marks, and numbers, adaptable to multiple languages worldwide.

Ability-based Design

According to (Wobbrock & Gajos,2018), ability-based design is an approach to design that emphasizes the human abilities required to use technology in specific contexts. This design principle is formulated to enable the operation and adaptation of technology to alternative abilities of users. There are several key characteristics of ability-based design:

- Pragmatic Approach: Focuses on leveraging human abilities to address practical user needs.
- Strategy-Agnostic: Combines various methods, including automatic

adaptation, high configurability, and multiple designs for alternative abilities.
- User-Centric: Shifts focus from systems to users, tailoring systems to users' abilities without rigid assumptions.
- On-board Adaptability: Emphasizes integrated adaptability for system adjustments in various user contexts.
- Connection with Inclusive/Universal Design: Supports designs adaptable to various abilities, aligning with universal design principles (Molly, F., Mace, R. L., & Mueller, J. L.,1998).
- Focus on Interactive Computing: Prioritizes technologies like detection, adaptation, and configuration in the design process.
- Awareness of Assistive Technology: Minimizes constraints and complexities to maximize user freedom with assistive technology.

Trewin and Pain (1999) pioneered innovative strategies to assist individuals with motor impairments through a dynamic keyboard system. Their analysis of typing performance led to the development of a sophisticated user model that tracked metrics like average key-press duration, double-presses, and CAPS LOCK usage for single-letter capitalization. By intercepting key presses before application engagement, their system offered adaptive recommendations, such as adjusting key debounce times to optimize typing efficiency and prevent errors.

Their dynamic keyboard model proved highly effective in detecting errors, including long key-press errors, simultaneous key presses, additional key errors, and bounce errors. Rooted in ability-based design principles, their approach emphasized transparency and compatibility with standard keyboards, offering suggestions rather than making discreet changes (Trewin & Pain, 1999). This work highlights the transformative potential of technology in addressing the needs of individuals with motor impairments and underscores the importance of ability-based design in promoting inclusivity and accessibility.

Building on these insights, our research question emerges: How can we develop a tool that enhances the integration of Braille signage into the daily lives of visually impaired individuals and their companions, adhering to ability-based design principles?

METHODOLOGY

The research methodology unfolded in five stages, anchored in the iterative and participatory Research through Design (RtD) approach. Initially, a comprehensive literature review established theoretical foundations. Primary research followed, involving immersive interviews and observations with relevant organizations to gather qualitative data on the challenges and requirements for a product tailored to companions of the blind and visually impaired.

After collecting data, we meticulously analyzed it to distill key design criteria and frameworks for the prototyping phase. The RtD approach enabled continuous refinement based on real-world insights and user needs. In the testing phase,

the prototype underwent rigorous evaluation through user reviews to assess its effectiveness and usability.
The RtD methodology's cyclical nature facilitated ongoing dialogue between designers and end-users, ensuring functional and resonant design solutions. The research culminated in identifying improvement areas, defining evaluation criteria, and proposing a refined design informed by iterative insights. This user-centric approach underscored our commitment to crafting inclusive and impactful solutions for companions of the blind and visually impaired.

RESULT & DISCUSSION

After conducting thorough analysis of both primary and secondary data, the authors identified key challenges faced by individuals with visual impairments, particularly their desire for increased independence in daily activities. Tasks such as choosing clothes and finding items were identified as major obstacles.

The study involved interviews with 15 visually impaired individuals and 7 companions of the blind. This prompted a shift in focus towards developing a solution tailored to address the specific challenges experienced by companions of individuals with visual impairments. These companions frequently encounter issues stemming from the interdependence that arises in their supportive roles.

Image 1 Observation and Interview. (Source: Pantiyoso, 2024)

Our analysis revealed the need for an identification system for the visually impaired, prioritizing ease of recognition, user-friendliness, and tactile feedback. Our product design incorporates Braille letters, enhancing legibility and tactile exploration, aligning with ability-based design principles.

By emphasizing inclusivity and universal design, our product is accessible to users with diverse abilities. Integrating Braille and tactile features meets the needs of visually impaired individuals and promotes an inclusive environment.

After analyzing primary and secondary data, we created sketches based on user feedback and research criteria, focusing on a handheld device for flexibility and mobility. These sketches were rigorously evaluated by users, leading to the final design selection.

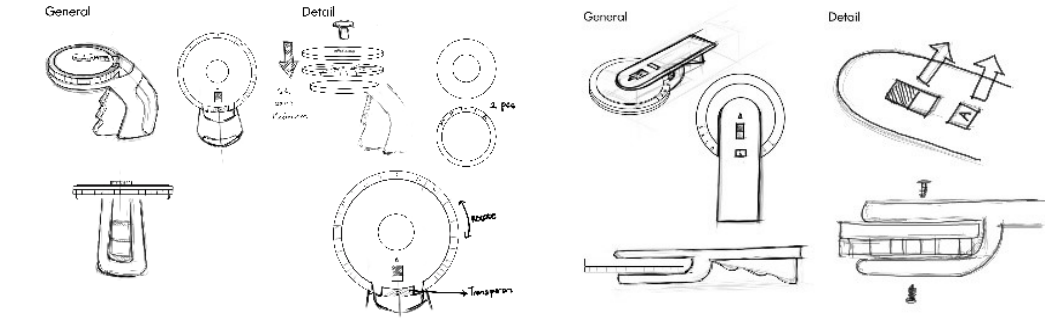

Image 2 Sketches. (Source: Pantiyoso, 2024)

Subsequently, the writer transitioned to the prototyping stage, employing advanced techniques such as 3D modeling and printing to bring the chosen design to life. Through a series of iterative prototyping iterations, with a keen focus on material research and ergonomic refinement, the final prototype, made with the material PLA+ and PLTE with the dimension of 154 x 56 mm, is meticulously crafted to meet the identified needs and preferences of the target users.

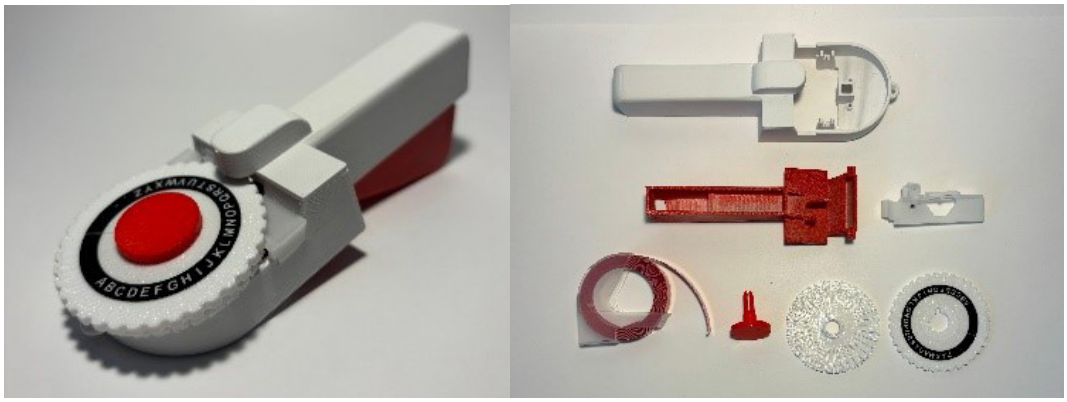

Image 3 Final Prototype. (Source: Pantiyoso, 2024)

Upon completion, the final prototype underwent comprehensive user testing , that consisted of 5 companions of the blind, to evaluate its effectiveness and usability in real-world scenarios. Feedback from companions revealed several key insights and positive reviews:

Image 4 User Testing. (Source: Pantiyoso, 2024)

The companions expressed novelty and enthusiasm in encountering such a labeling product, highlighting its uniqueness and potential utility in aiding individuals with visual impairments.
Ease of use emerged as a prominent feature, with users finding the product intuitive and straightforward to understand, enhancing their overall user experience.
Comparisons with existing tools, such as reglets, favored the prototype for its practicality, convenience, and potential to streamline everyday tasks.
The compact size of the product was lauded by users, as it facilitated easy transportation and usage in various environments and situations.
Ergonomic considerations were noted, with users finding the product comfortable to handle and operate, further enhancing its appeal and usability.
Furthermore, the prototype was deemed highly beneficial for companions in two main aspects:

- Facilitating the identification process for individuals with visual impairments, thereby improving their independence and quality of life.
- Assisting companions in learning Braille, thereby enhancing their ability to provide effective support to individuals with visual impairments.
- Additional features, such as the use of robust materials and the inclusion of a protective casing, further enhanced the product's appeal and usability, garnering praise from users. In summary, the final prototype received commendation for its innovation, practicality, and potential to significantly improve the daily lives of individuals with visual impairments and their companions.

Visual impairment poses multifaceted challenges for individuals, ranging from total blindness to varying degrees of residual vision. Moreover, navigating the world of Braille introduces a profound understanding of its nuanced standards and its pivotal role as a tactile writing system. This discussion delves into these intricate topics, shedding light on their complexities and underscoring the transformative potential of ability-based design principles.

Understanding Visual Impairment and Braille

The journey begins with an exploration of visual impairment, revealing the diverse spectrum of challenges encountered by individuals. From total blindness to residual vision, the experience of visual impairment encompasses a wide array of obstacles in accessing information and navigating daily life. Additionally, delving into Braille unveils its multifaceted nature, from its fundamental role as a communication system to its intricate standards regarding size, acronyms, and usage conventions. This foundational understanding sets the stage for the application of innovative design principles.

Embracing Ability-Based Design

Central to this discussion, with prior research from Wobbrock and Gajos (2018), is the concept of ability-based design, which offers a pragmatic approach to addressing the needs of individuals with visual impairments. By prioritizing user-centricity, inclusivity, and pragmatism, this design philosophy serves as a guiding

light in the development of solutions tailored to the unique challenges faced by the visually impaired community. Through the lens of ability-based design, designers embark on a journey of empathy and understanding, striving to empower individuals with visual impairments and enhance their independence.

From Theory to Practice

The seamless integration of ability-based design principles into real-world solutions is exemplified in the development of a Braille identification system. By analyzing primary and secondary data, the author uncover invaluable insights into the needs of visually impaired individuals, ranging from ease of recognition to tactile feedback integration. These insights inform the design process, culminating in a user-friendly and inclusive product, that is based on several ability-based design principles namely a pragmatic approach and user-centric design, that empowers individuals with visual impairments and fosters a more accessible society.

CONCLUSION

In summary, this discourse represents a voyage of exploration, beginning with unraveling the intricacies of visual impairment and Braille, and culminating in an appreciation of the empowering impact of designing with a focus on abilities. Through this journey, designers acquire fresh perspectives on the daily realities of those with visual impairments and the nuances of Braille as a form of communication. Ultimately, this odyssey underscores the significance of empathy, creativity, and inclusiveness in crafting solutions that significantly improve the quality of life for individuals with disabilities.

REFERENCES

Adopted texts - Rights of Persons with Disabilities - www.coe.int. (n.d.). Rights of Persons with Disabilities. https://www.coe.int/en/web/disability/adopted-texts

Molly, F., Mace, R. L., & Mueller, J. L. (1998). The Universal Design File: Designing for People of All Ages and Abilities. [E-book].

Perkins School for the Blind. (2007). Digitized Perkins annual reports – Perkins School for the Blind. https://www.perkins.org/archives/digitized-text-collections/digitized-perkins-annual-reports/

Shodorsmalls. (2000). BRL: Braille through Remote Learning. The Shodor Education Foundation, Inc.

Trewin, S., & Pain, H. (1999). Keyboard and mouse errors due to motor disabilities. International Journal of Human-Computer Studies, 50(2), 109-144.

Wobbrock, J. O., Gajos, K. Z., Kane, S. K., & Vanderheiden, G. C. (2018). Ability-based design. Communications of the ACM, 61(6), 62–71. https://doi.org/10.1145/3148051