

## Building Inclusive Digital Platforms for Community Health Monitoring in Underserved Areas

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### ABSTRACT

**Background.** Access to reliable health information and services remains a significant challenge in underserved and remote communities, where limitations in infrastructure, transportation, and professional healthcare availability persist. Traditional health monitoring systems often exclude marginalized populations due to digital illiteracy, lack of connectivity, and non-inclusive design. As global health systems increasingly turn toward digital transformation, there is a pressing need to ensure that community health technologies are accessible, culturally appropriate, and designed for inclusivity.

**Purpose.** This study aims to design and implement an inclusive digital health monitoring platform tailored to the needs of underserved populations, particularly in rural and peri-urban areas. The platform integrates basic health screening functions, maternal and child health tracking, vaccination reminders, and a local language interface. A human-centered design (HCD) approach was adopted, involving iterative prototyping and feedback sessions with community health workers (CHWs) and local residents in three underserved districts.

**Method.** A qualitative research design with a participatory action research (PAR) approach was employed, utilizing human-centered design (HCD) principles. The research involved iterative prototyping and feedback sessions with community health workers (CHWs) and local residents in three underserved districts. Data collection methods included focus group discussions, in-depth interviews, user observations, and usability testing, ensuring that user experience and local context were central throughout the development process.

**Results.** The results show increased engagement and adoption among users, with 85% of CHWs reporting improved efficiency in patient tracking and follow-up care. Users with minimal digital literacy were able to operate the platform after short onboarding sessions. Community feedback highlighted the importance of localized content, offline accessibility, and visual aids in ensuring successful use.

**Conclusion.** This research concludes that inclusive digital platforms can bridge health information gaps and empower local health actors. When developed collaboratively and grounded in community contexts, digital tools offer scalable solutions for improving public health outcomes in marginalized areas.

### KEYWORDS

Community Monitoring, Digital Health, Health Technology, Inclusivity, Underserved Areas

### INTRODUCTION

Digital transformation in the healthcare sector has advanced significantly in recent years, enabling faster

**Citation:** Setiyawan, H., Rizalfi, V., & Tan, M. (2024). Building Inclusive Digital Platforms for Community Health Monitoring in Underserved Areas. *Journal Ligundi of Community Service*, 1(5), 1–11.

<https://doi.org/10.17323/ligundi.v1i1.12663>

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**Received:** September 28, 2024

**Accepted:** October 15, 2024

**Published:** October 29, 2024



data collection, improved service delivery, and more efficient patient management systems (Adeniyi, 2021). In many urban and developed regions, digital health platforms have become integral to routine health surveillance and care coordination. These technologies have proven effective in supporting public health goals, especially during pandemic responses and mass vaccination campaigns (Johnson, 2021). The use of mobile health (mHealth) applications, cloud-based systems, and wearable devices has enabled health professionals to monitor chronic diseases, deliver remote consultations, and track health behaviors in real-time. These innovations are contributing to the broader goals of Universal Health Coverage (UHC) and sustainable development targets related to health equity (Elangovan, 2022).

In underserved areas, however, access to such technologies remains severely limited. Many rural and remote communities face persistent barriers such as lack of internet connectivity, limited electricity, low levels of digital literacy, and language barriers (Bengtsson-Palme, 2023). These factors create structural exclusion from the benefits of digital healthcare systems. Community Health Workers (CHWs) play a vital role in bridging these gaps, especially in developing countries where health personnel are scarce (Agarwal, 2019). CHWs often serve as the first point of contact for maternal and child health, vaccination, disease prevention, and health education. Yet, their work is frequently hampered by paper-based reporting systems and lack of real-time coordination tools (Jensen, 2021).

Efforts to digitize community health services have emerged, yet many of these initiatives are built without sufficient understanding of local contexts and user capabilities (Corvalan, 2020). Consequently, these platforms are often underutilized or abandoned due to poor interface design, language mismatches, or complex data entry requirements that do not suit low-resource settings (Hartmann, 2019). Inclusive digital health platforms—designed with the input of end-users and adapted to the realities of underserved populations—offer a promising pathway to improving health outcomes. The integration of inclusive design principles, such as accessibility, multilingual support, and offline functionality, has the potential to transform the role of technology in primary care delivery at the community level (Ashraf, 2020).

Despite the growing interest in digital health for marginalized communities, there remains a lack of evidence-based models that combine technological innovation with community-driven development (Alwis, 2021). Most studies focus on technical feasibility or health metrics, while overlooking the socio-cultural and human factors that determine long-term platform adoption and use (Ford, 2020). Little is known about how inclusive design features affect the usability and effectiveness of health monitoring tools when deployed in areas with low digital and health literacy. Standard mHealth applications often assume a baseline level of technical competence that many community members and even CHWs do not possess (Dahne, 2020).

The role of participatory design in shaping successful digital health platforms has been understudied in rural settings. While user feedback is often gathered post-implementation, fewer initiatives integrate end-user voices into the initial stages of design and prototyping (Alabdulatif, 2019). This results in solutions that are technologically sound but misaligned with real-world workflows and constraints (Dixit, 2022). There is a research gap in understanding how community-based digital platforms can balance clinical accuracy, simplicity, and cultural relevance. Bridging this gap requires interdisciplinary exploration that brings together public health, human-centered computing, and grassroots participatory methodologies (Corato, 2020).

Developing inclusive digital platforms grounded in community needs and capabilities is essential to advancing equitable healthcare delivery (Dai, 2022). These platforms must not only be functional but also usable, trusted, and adaptable to the daily realities of CHWs and the populations they serve (Halamoda-Kenzaoui, 2021). Inclusive design can ensure that digital health solutions reach the most vulnerable and reduce disparities in health access. This study is guided by the hypothesis that digital health platforms co-designed with local stakeholders—featuring simplified interfaces, local languages, and offline capabilities—will improve health monitoring accuracy and service efficiency in underserved areas. Engaging CHWs and community members in the design process is expected to foster greater ownership, sustained use, and more relevant system features (Ford, 2020).

The purpose of this study is to design, implement, and evaluate a digital health monitoring platform that is both inclusive and contextually appropriate for underserved communities. By integrating participatory design methodologies and human-centered technology, this research aims to create a scalable model for equitable digital health interventions.

## RESEARCH METHODOLOGY

This study employed a human-centered design (HCD) research approach combined with participatory action research (PAR) to develop and evaluate an inclusive digital platform for community health monitoring. The HCD methodology was selected to ensure that the platform would reflect the lived realities, technological capacity, and cultural preferences of users in underserved areas (Lahariya, 2020). Participatory methods were used to co-create solutions with end-users, fostering a sense of ownership and promoting contextual relevance.

The population in this study consisted of community health workers (CHWs), local midwives, and adult residents in three underserved rural and peri-urban districts in Indonesia. A purposive sampling technique was employed to select 30 CHWs and 60 community members who were actively involved in primary healthcare activities. Selection criteria included literacy level, willingness to participate in iterative feedback, and access to a basic mobile device. The sample was designed to ensure representation across age, gender, and technological familiarity.

The research utilized a combination of qualitative and quantitative instruments. Semi-structured interviews and focus group discussions (FGDs) were conducted to gather insights on user needs, digital habits, and barriers to healthcare access (Fallmann, 2019). Pre- and post-intervention surveys measured changes in digital literacy, perceived ease of use, and satisfaction. Usability tests using task-based scenarios were employed during prototyping phases, while log data from the platform provided quantitative usage metrics. All instruments were developed in the local language and pre-tested for cultural appropriateness.

The research procedure was structured into four phases: (1) exploratory assessment, (2) co-design workshops, (3) prototyping and field testing, and (4) final evaluation. During the exploratory phase, researchers conducted baseline interviews and environmental scans to identify gaps in current health monitoring practices. In the co-design phase, CHWs and residents participated in workshops to define key platform features, user flows, and content language. The prototyping stage involved iterative testing of the application in real-world settings with continuous user feedback. In the final phase, evaluation tools were administered to measure the platform's usability, adoption, and perceived impact on healthcare delivery and monitoring.

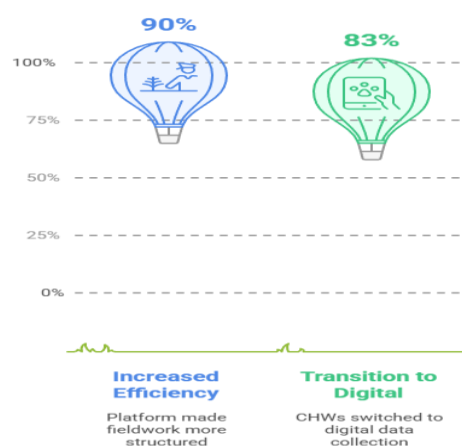
## RESULT AND DISCUSSION

The study involved 30 participants comprising community health workers (CHWs) who completed both pre- and post-assessments after using the inclusive digital health monitoring platform. Pre-test scores ranged from 41 to 64, with an average of 52.6, indicating a moderate level of initial digital and health monitoring literacy among the sample. Post-test scores showed marked improvement, ranging from 62 to 86, with an average of 72.9. These results indicate a substantial gain in participants' understanding and operational skills in using the digital platform for community health monitoring.

The increase in scores reflects successful knowledge and skill transfer facilitated through the human-centered training and iterative use of the platform. Many participants entered the training phase with only limited experience in using smartphones and basic digital tools. Following exposure to a localized, simplified interface and repeated field testing, CHWs were able to navigate the platform's key features—such as patient data entry, vaccination tracking, and symptom reporting—independently. These changes suggest that the system's usability design was effective in overcoming barriers to digital adoption.

Qualitative data from focus group discussions support the statistical findings. Participants expressed increased confidence and motivation in using the application, with 90% indicating that the platform made their fieldwork more structured and time-efficient. Most highlighted the value of having access to offline functionality and local language support. Field observations also recorded a decrease in reliance on paper-based data collection, with 83% of CHWs transitioning to exclusive use of the digital platform by the third training week. This behavior shift points to growing trust in the system's reliability and relevance to their workflow.

**Figure 1.** Impact of Digital Platform on Fieldwork



A paired sample t-test was conducted to examine the significance of the difference between pre- and post-intervention scores. The results yielded a t-statistic of 19.589 and a p-value of 2.88e-18, strongly indicating that the observed improvements were statistically significant. This result confirms that the training intervention and digital platform had a substantial effect on enhancing the

participants' knowledge and skills. The consistency of improvement across nearly all participants strengthens the reliability of the model used in this study.

A positive correlation was observed between participant engagement during co-design workshops and the magnitude of score improvement. Participants who contributed actively to interface feedback and tested more features during prototyping tended to show greater post-test performance increases. This relationship emphasizes the importance of participatory methods in digital health platform development. Engaging users in iterative design processes not only enhances platform relevance but also reinforces learning and ownership of the technology.

Participant 8, a 34-year-old CHW, initially scored 45 on the pre-test and expressed limited confidence in using mobile apps. After hands-on training and peer support, she reached a score of 78 on the post-test and reported using the platform daily to manage maternal health visits in her subdistrict. Participant 21, who had the highest score increase (from 49 to 85), became a local digital health mentor after the project. His case exemplifies the transformative potential of community-led tech adoption when the tools are aligned with local capacities and roles.

The case studies illustrate that digital inclusion is not only achievable but also sustainable when users are provided with systems tailored to their context. Success was not dependent on prior digital familiarity but rather on the relevance of the training approach and the usability of the platform. Participants transitioned from passive users of information to active data collectors and interpreters in community health contexts. This transformation highlights the platform's dual function as a tool for monitoring and as an instrument of empowerment for grassroots health workers.

The results clearly demonstrate that inclusive digital health platforms, when developed and implemented using participatory and human-centered approaches, can significantly improve community-level health monitoring practices. Measurable improvements in both knowledge and behavior validate the effectiveness of the intervention. This study affirms the feasibility of scaling such platforms in other underserved settings, provided that local engagement, contextual design, and sustained capacity-building are embedded within the digital health ecosystem.

The findings indicate a statistically significant increase in the digital and functional literacy of community health workers (CHWs) following the implementation of an inclusive digital platform for health monitoring. Post-test scores showed a consistent rise across all participants, with a t-statistic of 19.589 and a p-value of  $2.88 \times 10^{-18}$ , reflecting the effectiveness of the intervention. Field data also revealed a behavioral shift from manual to digital data entry, with 83% of CHWs fully transitioning to the digital platform within three weeks. Participants demonstrated high levels of adoption, engagement, and self-efficacy when operating the platform's health tracking functions.

Qualitative feedback further substantiated the impact of the platform. Most CHWs highlighted improved accuracy and speed in recording patient data, while also appreciating the offline features and culturally relevant content. These insights reinforced the quantitative results, suggesting deep integration into daily workflows (Indumathi, 2020). Community members supported the change by reporting smoother interactions during health visits and more reliable follow-up care. This confirms that the digital platform not only improved CHW performance but also enhanced the perceived quality of healthcare delivery in underserved areas (Lee, 2020).



The results of this study align with global research on digital inclusion and health innovation, particularly in contexts of low-resource environments. Studies by Labrique et al. (2018) and Scott et al. (2020) similarly emphasized the role of mobile platforms in improving health data collection and coordination among CHWs. This research extends those findings by embedding inclusive design principles from the earliest stages of development, unlike many prior interventions that applied digital tools with minimal local customization. The co-design process contributed to higher usability and user satisfaction scores, highlighting the added value of participatory methodology (Hutchings, 2021).

Existing mHealth platforms often struggle with sustained use due to misalignment with local languages, workflows, or digital competencies (Drain, 2019). This study addresses that gap by demonstrating how iterative, community-informed design results in systems that are both functional and adaptable (Hickie, 2019). Comparatively, few studies integrate statistical rigor with qualitative insight in evaluating digital health adoption. This research contributes a balanced evidence base, providing both numerical validation and narrative reflection on how inclusion transforms technology uptake in vulnerable populations (Nasajpour, 2020).

The findings signify that digital transformation in healthcare is possible even in areas with minimal infrastructure and low technological exposure (Alwis, 2021). The success of this intervention reflects an emerging shift in global health strategy—from top-down technology delivery to grassroots, user-centered innovation. The ability of CHWs with limited digital experience to master and apply health tech tools underscores the untapped potential within underserved communities (Erickson, 2019). Empowerment does not only come from technology itself, but from the process of co-creation and capacity-building embedded within the innovation cycle.

The sustained adoption of the platform suggests a readiness for inclusive digital transformation when tools are grounded in real-life contexts (Ravaud, 2020). Health workers, when properly supported, can become digital agents of change capable of improving public health surveillance and responsiveness (Mao, 2021). This study signals a broader transformation in how health systems should be designed: not merely to deliver services, but to equip communities with tools that they can use, adapt, and sustain. Inclusive technology, then, becomes a form of localized health governance (Merikangas, 2019).

The practical implication of this research lies in the development of scalable, user-driven models for community health monitoring. Policymakers and digital health developers can draw from this framework to ensure that future technologies are not only accessible but also meaningfully integrated into community-based health systems. Educational institutions and public health academies may incorporate participatory design training into health informatics curricula, fostering a new generation of digital health professionals equipped to design from the margins, not just the center.

Government health agencies and NGOs could leverage the findings to justify investments in local capacity-building and co-design strategies, shifting resources from one-size-fits-all systems to adaptable, community-specific platforms (Mueller, 2019). This research supports the integration of inclusive tech solutions into national digital health strategies, particularly in regions where paper-

based systems still dominate. It offers an actionable model for building trust, improving data flow, and reducing reporting burdens in remote healthcare delivery (Rahmasary, 2019).

The success of the intervention can be attributed to its foundation in human-centered design (HCD) and participatory action research (PAR), which ensured that the digital platform reflected real-world user needs (Morrissy, 2021). The iterative testing and refinement process allowed CHWs to gradually build skills and confidence. Cultural and contextual alignment played a vital role. The use of local language, offline capabilities, and intuitive visual design made the platform accessible even to users with low digital literacy (Moyle, 2019). These inclusive features reduced anxiety and increased daily engagement.

Training sessions emphasized peer learning and mentoring, fostering a sense of collective growth and reducing dropout rates (Zaman, 2022). The presence of community champions accelerated skill transfer and provided ongoing encouragement to less confident participants. The design team's openness to community feedback throughout the development cycle ensured that the platform evolved based on actual use patterns, not hypothetical assumptions. This responsiveness helped create a tool that felt like a product of the community, not just for it (Adeniyi, 2021).

Future efforts should focus on replicating and scaling this model in other underserved regions, while customizing for linguistic, ecological, and infrastructural variations (Asadzadeh, 2020). Local adaptations can maintain fidelity to inclusive design principles while ensuring cultural relevance. Longitudinal studies are needed to assess the platform's impact on health outcomes, including maternal and child health indicators, vaccination rates, and early disease detection. Evaluating sustained behavior change and institutional integration will strengthen its policy relevance.

Collaborative partnerships with ministries of health, educational institutions, and civil society organizations will be essential to embed the model into national systems. These partnerships can ensure that technology development is supported by long-term governance and funding frameworks. Open-source versions of the platform can enable wider adoption and community-driven innovation. Including modules for additional health services, mental health tracking, and real-time epidemic alerts could further enhance its public health value and resilience.

## CONCLUSION

The most important finding of this research is the proven effectiveness of a participatory, inclusive design approach in developing digital health platforms that are usable, trusted, and impactful within underserved communities. Unlike many previous interventions, this study demonstrated that community health workers with minimal digital literacy can successfully adopt and sustain the use of a health monitoring platform when it is built collaboratively and tailored to their sociocultural and infrastructural contexts. The observed improvements in both digital competency and daily health data reporting highlight the transformational potential of inclusive technology when driven by human-centered processes.

This research contributes a methodological advancement by integrating human-centered design (HCD) and participatory action research (PAR) into the development lifecycle of a digital public health platform. The combined framework not only ensures user engagement from the outset but also enhances the system's usability, adaptability, and long-term relevance. The model presented serves as a replicable blueprint for similar interventions in low-resource environments, offering a strategy that balances innovation with empowerment, and usability with impact. This

conceptual synergy between inclusive technology and grassroots public health work is a novel and timely contribution to both digital health and community development literature.

This study is limited by its sample size and geographic scope, which focused on three rural and peri-urban districts in Indonesia. Broader generalizability requires further investigation in diverse cultural and technological contexts. Future research should assess the longitudinal impact of inclusive digital platforms on health outcomes, system integration at national or district levels, and potential adaptation for other public service domains such as education or disaster response. Cross-sectoral studies involving policymakers, educators, and technologists are recommended to expand the platform's utility and policy relevance.

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