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IMPROVING DIGITAL HEALTH READINESS AMONG COMMUNITY HEALTH CADRES THROUGH THE AHHEM MODEL

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ABSTRAK

Transformasi digital kesehatan menuntut kesiapan sumber daya manusia, khususnya kader kesehatan sebagai ujung tombak pelayanan masyarakat. Namun, rendahnya literasi digital dan dominannya pencatatan manual menjadi tantangan signifikan dalam mendukung implementasi sistem kesehatan berbasis digital. Kegiatan pengabdian ini bertujuan meningkatkan pemahaman dan kesiapan kader dalam menghadapi transformasi digital kesehatan. Kegiatan dilaksanakan di Desa Karangrau, Kabupaten Banyumas, melibatkan 25 peserta yang terdiri dari satu bidan desa dan 24 kader kesehatan. Metode yang digunakan adalah *Adaptive Hybrid Health Empowerment Monitoring Model* (AHHEM), yang mengintegrasikan tahapan analisis awal, penyelarasan program, literasi kesehatan digital, pemberdayaan, dan evaluasi selama satu hari penuh. Evaluasi dilakukan menggunakan desain pre-test dan post-test untuk mengukur perubahan kognitif. Hasil kegiatan menunjukkan peningkatan yang substansial pada pemahaman peserta, dari 53% pada pre-test menjadi 89% pada post-test. Peserta juga menunjukkan kesiapan yang lebih baik dalam memahami peran teknologi digital dan sistem informasi kesehatan. Keunggulan pendekatan ini terletak pada fokusnya terhadap kesiapan manusia, bukan hanya implementasi teknologi. Dengan demikian, program ini memperkuat kapasitas kader dan mendukung implementasi transformasi digital kesehatan yang berkelanjutan di tingkat komunitas.

Kata Kunci: Transformasi Digital Kesehatan; Kader Kesehatan; Sistem Informasi Kesehatan

ABSTRACT

Digital health transformation requires human resource readiness, particularly community health cadres who serve as the frontline of community-based services. However, limited digital literacy and reliance on manual record-keeping present significant challenges in supporting digital health system implementation. This community service program aims to enhance the understanding and readiness of health cadres in facing digital health transformation. The activity was conducted in Karangrau Village, Banyumas Regency, involving 25 participants consisting of one

village midwife and 24 health cadres. The method applied was the Adaptive Hybrid Health Empowerment Monitoring Model (AHHEM), integrating assessment, harmonization, health literacy, empowerment, and evaluation over a one-day intervention. The evaluation employed a pre-test and post-test design to measure cognitive shifts. The results showed a substantial improvement in participants' understanding, increasing from 53% in the pre-test to 89% in the post-test. Participants also demonstrated improved readiness in understanding the role of digital technology and health information systems. The main strength of this approach lies in its focus on human readiness rather than solely on technological implementation. Therefore, this program strengthens cadre capacity and supports the sustainable implementation of digital health transformation at the community level.

Keywords: Digital Health Transformation; Health Cadres; Health Information System

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1. INTRODUCTION

Digital health transformation is a strategic agenda aimed at improving service effectiveness through the integration of technology and health data. In Indonesia, this is anchored by the National Health Information System (SIKN), which seeks to unify health recording and reporting mechanisms (Hanafi et al., 2025). However, a significant gap remains between national policy mandates and the readiness of frontline human resources. In Karangrau Village, community health cadres serve as the primary touchpoint for community-based services but struggle with low digital literacy and a limited conceptual understanding of the SIKN (Yuniati et al., 2023). Consequently, manual record-keeping still dominates, resulting in delayed reporting, data inaccuracies, and the suboptimal use of health data for local decision-making.

Previous community service initiatives aimed at digitalizing health services have predominantly focused on technical training for specific applications. While these interventions improve basic technical skills, they often fail to cultivate a holistic understanding of the broader national health information architecture (Haynes et al., 2020; Sheikh et al., 2021). This tool-centric approach risks creating technological dependency without fostering the adaptive capacity and conceptual readiness required for sustainable systemic transformation at the grassroots level (Nurlaila et al., 2024).

To address this limitation, a paradigm shift is required from merely introducing technological tools to building comprehensive human resource readiness. The Adaptive Hybrid Health Empowerment Monitoring Model (AHHEM) offers a novel framework that

integrates education, capacity building, and systemic evaluation (Rodiyah et al., 2024). By emphasizing adaptive readiness and conceptual literacy, this model empowers cadres to transition from passive tool users to active educational agents (Rijal et al., 2023). Therefore, this program aims to enhance the understanding and adaptive readiness of community health cadres in facing digital health transformation using the AHHEM approach. Implemented in Karangrau Village, this initiative bridges the gap between national policies and grassroots implementation, providing a sustainable, human-centric model for community-level health information readiness.

2. METHOD

This community service program utilized a pre-experimental design with a one-group pre-test and post-test approach, conducted in Karangrau Village, Banyumas Regency, Central Java, Indonesia. The activity was executed over a three-month period from March to May 2025, with the core intervention delivered during a one-day (8-hour) intensive session. The participants comprised 25 individuals, specifically one village midwife and 24 community health cadres. The inclusion criteria for participant selection were: (1) being an active community health cadre or health worker in Karangrau Village, (2) willingness to participate in the entire program and sign the informed consent, and (3) ability to attend the intervention from start to finish. Cadres who were inactive or unable to attend the full session were excluded from the final evaluation to ensure data completeness.

The intervention utilized the Adaptive Hybrid Health Empowerment Monitoring Model (AHHEM), a systematic framework designed to build human readiness for the National Health Information System (SIKN). The training materials consisted of contextualized modules covering SIKN concepts, digital health literacy, the strategic role of cadres, and basic digital navigation, all designed with visual aids to prevent cognitive overload. The program was facilitated by a team of public health academics and health informatics experts from Universitas Harapan Bangsa, all holding a minimum of a Master's degree in Public Health or Health Informatics, with extensive experience in community empowerment. The AHHEM procedures were executed in five sequential phases: (1) Assessment, involving field observations and focus group discussions to map baseline digital literacy and manual workflows; (2) Harmonization, translating complex national policies into accessible, localized language and analogies; (3) Health Literacy, delivering foundational knowledge on digital health transformation; (4) Empowerment, facilitating interactive, participatory sessions such as role-playing and group discussions to relate concepts to daily tasks; and (5) Monitoring and Evaluation, involving continuous observation and structured quantitative evaluation.

The evaluation instrument was a structured 10-item questionnaire measuring digital health understanding, SIKN comprehension, technology readiness, and the perceived role of cadres. Content validity was established through expert judgment by three public health and health informatics experts, yielding a Content Validity Index (CVI) of 0.89. Following revisions, a pilot test conducted on 10 non-participant cadres in a neighboring village resulted

in a Cronbach's Alpha value of 0.82, indicating good internal consistency. Although the questionnaire utilized a Likert-scale format, the final scores were converted into a percentage index to facilitate the interpretation of comprehension levels, calculated as: (Total Obtained Score / Maximum Possible Score) x 100%. The scoring interpretation was categorized as follows: 0-50% (Low understanding), 51-75% (Moderate understanding), and 76-100% (High understanding).

This community service program adhered to the ethical principles of community engagement. Ethical approval was obtained from the Health Research Ethics Committee of Universitas Harapan Bangsa (Ethical Clearance No: 045/KEPK-UHB/III/2025). Prior to the intervention, written informed consent was obtained from all participants, who were assured of data confidentiality, anonymity, and their right to withdraw at any time without consequence. For data analysis, both descriptive and inferential statistical methods were employed. Descriptive statistics, including mean and percentage comparisons, illustrated the magnitude of improvement. To determine whether the difference between the pre-test and post-test scores was statistically significant, the Wilcoxon signed-rank test was employed, as the data were paired and the sample size (n=25) did not assume a normal distribution. The statistical analysis was performed using SPSS version 26, with a significance level set at $p < 0.05$.

3. RESULTS AND DISCUSSION

RESULTS

a. Initial Assessment and Identification of Grassroots Challenges

The initial assessment phase was meticulously designed to map the existing operational conditions and digital readiness of community health cadres in Karangrau Village. Field observations and direct coordination with local health partners revealed a significant gap between national digital health policies and grassroots implementation realities. The cadres demonstrated a heavy reliance on conventional manual recording methods, which inherently increased the risk of data inaccuracies and delayed reporting mechanisms. Furthermore, the participants exhibited a fundamental lack of conceptual understanding regarding the National Health Information System and its strategic role in modern healthcare delivery. This foundational evaluation highlighted that the primary barrier was not merely a lack of technological access, but a profound deficit in adaptive cognitive readiness.

These empirical findings underscored the urgent need for an intervention that transcends basic technical training and addresses underlying conceptual vulnerabilities. The dominance of manual workflows indicated that cadres were operating in an isolated informational silo, disconnected from the broader national health data ecosystem. Consequently, their capacity to utilize health data for proactive community education and evidence-based decision-making remained severely constrained. Identifying these specific vulnerabilities allowed the implementation team to tailor the subsequent educational modules directly to the participants' actual operational contexts. This targeted approach ensured that the intervention

would resolve systemic misunderstandings rather than just providing superficial technological exposure.

Table 1. Initial Problem Identification of Health Cadres

No	Aspect	Findings	Impact
1	Digital Literacy	Cadres are unaccustomed to using technology as a health education medium	Limitations in accessing and delivering digital-based information
2	SIKN Understanding	Cadres do not understand the concept and function of the National Health Information System	Lack of readiness in facing digital-based health system transformation
3	Data Recording	Health activity recording is still done manually	Potential for data errors and reporting delays
4	Technology Utilization	Technology is not utilized as a means to support health education	Health information is less optimal in reaching the community

The data presented in the table clearly illustrates the multifaceted nature of the challenges faced by the health cadres prior to the intervention. Each identified problem directly correlates with a specific negative impact on the overall quality and efficiency of community health service delivery. Addressing these interconnected issues required a comprehensive strategy that simultaneously targeted digital literacy, conceptual knowledge, and practical workflow optimization. Ultimately, this detailed mapping served as the critical baseline for measuring the subsequent cognitive and operational shifts achieved through the empowerment program.

b. Program Harmonization and Contextualized Health Literacy

Following the initial assessment, the harmonization phase focused on aligning the complex concepts of digital health transformation with the socio-cultural realities of the participants. The implementation team deliberately simplified the educational materials, ensuring that the language and examples used were highly contextual and easily digestible for the cadres. This strategic adaptation prevented cognitive overload and fostered a more inclusive learning environment for individuals with varying educational backgrounds. By bridging the gap between abstract national policies and local community health practices, the materials became immediately relevant to the participants' daily responsibilities. This harmonization process was crucial in transforming intimidating technological concepts into accessible and actionable knowledge.

The health literacy component subsequently built upon this harmonized foundation by introducing the core principles of the National Health Information System. Participants were guided through the critical importance of standardized health data management and its direct impact on resource allocation and policy formulation. The educational sessions emphasized that digital transformation is fundamentally about improving patient outcomes through

integrated information flows, rather than merely adopting new software tools. This conceptual reframing helped the cadres visualize their specific roles within the broader national health architecture. Consequently, they began to perceive themselves as vital data nodes rather than isolated administrative workers.

Figure 1. Delivery of educational materials to participants

The visual documentation of the educational delivery highlights the highly communicative and engaging approach utilized during the health literacy sessions. The facilitators employed interactive storytelling and localized analogies to demystify complex digital health architectures for the grassroots participants. This visual evidence confirms that the pedagogical strategy successfully maintained high levels of attention and cognitive engagement throughout the intensive material delivery. The supportive learning atmosphere visibly encouraged the cadres to ask questions and actively connect the new concepts to their existing community health experiences.

c. Participatory Empowerment and Qualitative Feedback

The empowerment phase transitioned the participants from passive recipients of information into active agents of digital health transformation within their communities. Interactive discussion sessions were facilitated to allow cadres to share their practical experiences, operational bottlenecks, and personal perspectives on technology integration. This participatory approach generated rich qualitative feedback, revealing a gradual but significant shift in their mindset regarding digital health tools. Participants expressed newfound confidence in their ability to interpret health data and communicate its importance to the broader community. The dialogue also uncovered practical strategies for integrating digital concepts into their existing manual workflows during the transitional period.

Qualitative feedback was collected through Focus Group Discussions (FGD) conducted immediately after the empowerment session and analyzed using thematic analysis to identify core shifts in the participants' mindsets. The thematic analysis revealed a profound transformation in how the cadres perceive their professional identity and societal role. One village midwife noted that understanding the national system made her realize how her daily manual records eventually contribute to macro-level national health planning. Another cadre expressed that the conceptual clarity removed their previous fear of technological obsolescence, replacing it with a strong sense of adaptive readiness. These reflections

demonstrated that the intervention successfully cultivated intrinsic motivation and a proactive attitude toward future technological implementations.

Figure 2. Interactive discussion between participants and the implementation team

The photographic evidence of the interactive discussions and training activities vividly captures the high degree of participant engagement and collaborative learning. The cadres are observed actively pointing at educational modules, debating practical applications, and sharing localized solutions with their peers. This visual data corroborates the qualitative feedback, illustrating a vibrant knowledge-exchange ecosystem that transcended traditional top-down instructional methods. The physical proximity and enthusiastic body language of the participants further validate the success of the participatory empowerment strategy in building collective confidence.

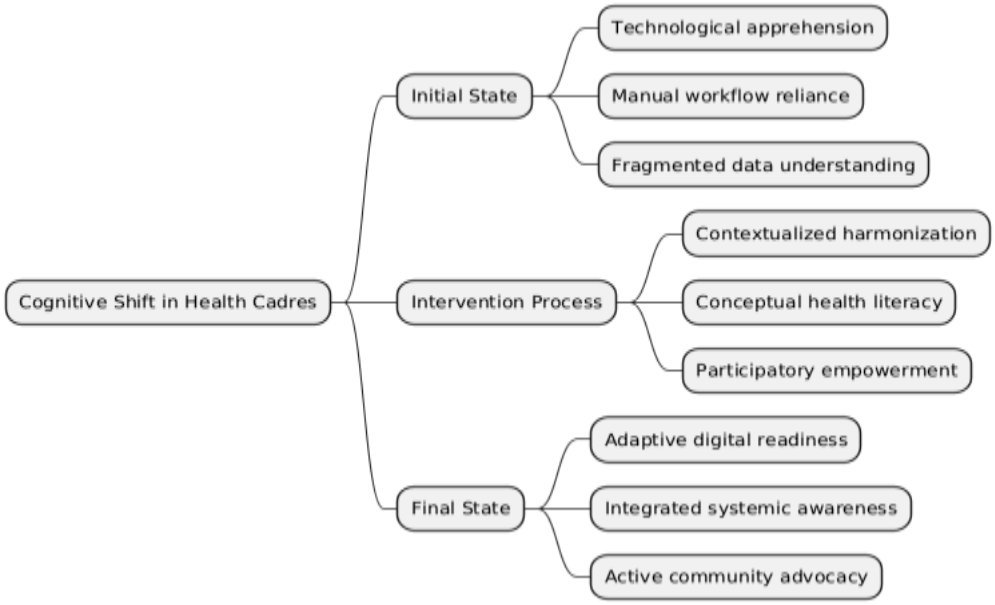

Figure 3. The Cognitive and Operational Transition Experienced by The Health Cadres

The provided diagram systematically maps the cognitive and operational transition experienced by the health cadres throughout the empowerment process. It visually delineates the progression from initial technological apprehension to conceptual clarity, and ultimately to adaptive readiness and active community advocacy. This structural representation

underscores the holistic nature of the intervention, highlighting that sustainable digital transformation requires sequential psychological and intellectual milestones. The model serves as a replicable framework for understanding how grassroots health workers internalize and operationalize national digital health policies.

d. Quantitative Evaluation of Digital Health Comprehension

The quantitative evaluation utilized a structured 10-item Likert-scale questionnaire, where each item was scored from 1 to 4. The total raw score for each participant was calculated and converted into a percentage index using the formula: (Total Obtained Score / Maximum Possible Score) x 100%. The overall average percentage demonstrated a substantial elevation, increasing from a baseline of 53% (Mean raw score = 21.2, SD = 2.4) to 89% (Mean raw score = 35.6, SD = 1.8) post-intervention.

To determine the statistical significance of this improvement, a Wilcoxon signed-rank test was conducted, as the data were paired and non-normally distributed. The results revealed a statistically significant difference between the pre-test and post-test scores ($Z = -4.32$, $p < 0.001$), confirming that the AHHEM intervention effectively and significantly enhanced the participants' digital health comprehension. A granular analysis of the specific indicators reveals that the most dramatic improvements occurred in the understanding of the National Health Information System (SIKN), which jumped from 50% to 90%, and the understanding of the cadres' specific roles, which increased from 54% to 91% (Table 2).

Table 2. Evaluation Results of Participant Understanding Based on Indicators

No	Indicator	Pre-test (%)	Post-test (%)	Description
1	Digital Health Understanding	52	88	Increased significantly
2	SIKN Understanding	50	90	Increased very well
3	Technology Readiness	55	87	Increased significantly
4	Cadre Role	54	91	Increased very well
	Average	53	89	Effective

The tabulated data provides a clear, quantitative breakdown of the cognitive improvements achieved across the four primary evaluation indicators. The consistent and substantial percentage increases across all categories demonstrate that the intervention produced a balanced enhancement of both technical understanding and strategic awareness. Particularly noteworthy is the near-universal comprehension of the cadres' evolving roles, which is critical for the sustained implementation of digital health initiatives at the grassroots level. This quantitative evidence firmly establishes the statistical significance of the educational program in bridging the initial digital literacy gap.

e. Visual Analysis of Cognitive Shift and Adaptive Readiness

To complement the tabular data, a visual comparative analysis was conducted to illustrate the proportional distribution of participant comprehension before and after the intervention. The graphical representation highlights a dramatic structural shift in the cohort's overall digital health literacy and adaptive readiness. The pre-intervention distribution showed a heavy concentration of participants in the lower and middle comprehension tiers, reflecting widespread foundational vulnerabilities. Conversely, the post-intervention visualization demonstrates a massive consolidation of participants into the highest proficiency tiers, indicating a successful systemic cognitive upgrade. This visual evidence powerfully communicates the sheer scale of the transformation achieved within a single, highly structured educational engagement.

The visual data also underscores the uniformity of the intervention's impact, as there were no significant outliers left behind in the lower comprehension brackets. This equitable distribution of knowledge gain suggests that the harmonization phase successfully accommodated the diverse learning speeds and educational backgrounds of the participants. The graphical shift from a fragmented understanding to a cohesive, high-level comprehension profile is a strong indicator of the program's pedagogical effectiveness. It proves that the adaptive hybrid model can rapidly elevate the collective baseline of digital health literacy in resource-constrained community settings. Ultimately, this visual proof reinforces the argument that human readiness must precede and accompany technological deployment.

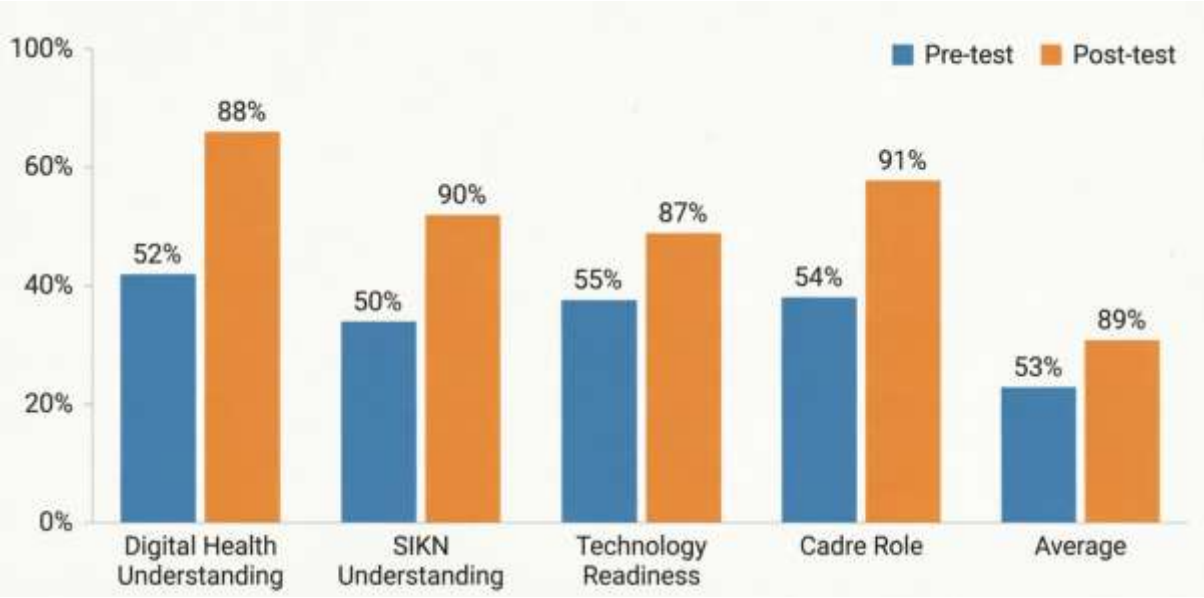

Figure 4. Comparison of Pre-test and Post-test Results

The comparative graphical illustration provides an immediate, intuitive understanding of the massive cognitive shift experienced by the health cadres. The stark contrast between the pre-test and post-test distributions visually validates the quantitative data, making the magnitude of the improvement instantly comprehensible to policymakers and stakeholders. This visual tool effectively translates complex statistical gains into a compelling narrative of

grassroots empowerment and successful capacity building. It serves as a vital piece of evidence demonstrating that targeted, conceptually focused education can rapidly overcome initial digital literacy barriers.

f. Strategic Implications for Sustainable Community Health Transformation

The comprehensive results of this community service program carry profound strategic implications for the broader implementation of national digital health policies. The empirical evidence demonstrates that prioritizing human readiness and conceptual literacy yields far more sustainable outcomes than merely distributing technological tools to unprepared communities. By successfully transforming the cadres' mindsets and enhancing their adaptive capacities, the intervention created a resilient foundation for future technological integrations. The cadres are now equipped not only to operate new systems but also to advocate for their utility and troubleshoot basic conceptual issues within their communities. This shift from passive recipients to active educational agents ensures that the impact of the program will continue to reverberate long after the initial intervention concludes.

Furthermore, the success of this adaptive hybrid model provides a scalable blueprint for other regions facing similar digital literacy challenges and infrastructural limitations. The findings suggest that national health ministries should integrate similar conceptual empowerment modules into their standard digitalization rollouts to prevent systemic friction. Investing in the cognitive readiness of frontline health workers will ultimately minimize the risks of data fragmentation, reporting delays, and technological abandonment. As the national health information ecosystem continues to expand, the adaptive cadres of Karangrau Village stand as a testament to the power of human-centric digital transformation strategies. Their enhanced readiness ensures that the ultimate goal of integrated, evidence-based community healthcare remains firmly within reach.

Ultimately, the transition from manual vulnerabilities to digital confidence observed in this program highlights the critical importance of adaptive empowerment models. The integration of continuous monitoring and participatory learning ensured that the acquired knowledge was deeply internalized rather than superficially memorized. As these empowered cadres return to their respective communities, they carry the capacity to drive localized digital health initiatives with clarity and purpose. This localized capacity building is the essential missing link that will eventually allow the National Health Information System to function as a truly integrated, nationwide ecosystem.

DISCUSSION

The findings of this community service program demonstrate a statistically significant and substantial improvement in the digital health literacy of community health cadres, with comprehension scores increasing from 53% to 89% ($p < 0.001$). This cognitive shift directly addresses the persistent challenges in implementing the National Health Information System (SIKN) at the primary care level. Previous literature has consistently highlighted that while national health policies mandate digital integration, actual implementation is frequently

hindered by manual workflows and inadequate human resource preparedness (Aisyah et al., 2025; Islam et al., 2025; Suardi et al., 2026). Furthermore, studies indicate that the mere deployment of health information systems does not automatically translate to improved service quality unless operators possess a foundational understanding of the system's ecosystem (Cao et al., 2026; Gashu, 2024; Mukherjee et al., 2025). Our findings align with and extend this literature by empirically proving that bridging the conceptual gap through structured empowerment is a prerequisite for effective health data management.

Unlike previous initiatives that prioritized the technical deployment of specific digital applications or smart village infrastructure (Mohanty et al., 2020; Stojanova et al., 2021), this study emphasizes conceptual harmonization over mere tool utilization. A tool-centric approach often leads to technological dependency and high abandonment rates when users lack a holistic understanding of the digital transformation paradigm (Bandara et al., 2026; Sabani et al., 2026). By contrast, the AHHEM approach ensures that cadres comprehend the 'why' and 'how' of the SIKN before engaging with the 'what' of technological tools. This paradigm shift from technical training to adaptive cognitive readiness prevents superficial adoption and fosters a resilient digital culture at the grassroots level, strongly supporting the assertions of Rijal et al., (2023) that sustainable IT utilization is entirely contingent upon targeted human capacity development.

The success of this intervention also highlights the critical importance of aligning national policies with grassroots realities to prevent policy failure at the implementation stage (Djatmiko et al., 2025). The digital transformation of health services is a complex organizational change that requires adaptive management strategies to overcome systemic resistance (Brommeyer et al., 2024; Hundal et al., 2025; Tsekouropoulos et al., 2025). By harmonizing complex national SIKN concepts into accessible, context-specific modules, the program successfully leveraged digital health literacy as a tool for community empowerment (Rangachari et al., 2025; Simba et al., 2026). The active involvement of local stakeholders demonstrates that collaborative community empowerment is vital for sustaining digital health initiatives (Ernawati et al., 2024; Luthfi et al., 2024). Ultimately, the AHHEM model provides a scalable, human-centric blueprint for policymakers, proving that investing in the adaptive readiness of community health cadres is the most strategic pathway toward achieving a fully integrated National Health Information System.

4. CONCLUSION

The community service program implemented in Karangrau Village demonstrates that the Adaptive Hybrid Health Empowerment Monitoring Model (AHHEM) is a promising approach for enhancing the conceptual understanding and digital health readiness of community health cadres. The intervention successfully addressed initial vulnerabilities characterized by low digital literacy and reliance on manual record-keeping, resulting in a substantial improvement in comprehension scores from 53% to 89%. This cognitive shift indicates that prioritizing human readiness and conceptual harmonization can effectively

bridge the gap between national digital health policies and grassroots understanding, transforming cadres from passive data recorders into more confident agents of health education.

However, the findings of this study must be interpreted within the context of several limitations. First, the research was conducted in a single-village setting with a relatively small sample size (n=25), which limits the generalizability of the results to broader or more diverse populations. Second, the pre-experimental design lacked a control group, making it difficult to isolate the intervention's effect from other external variables. Third, the evaluation relied on a short-term, immediate post-test assessment, providing no longitudinal data on knowledge retention over time. Finally, while the study measured a significant cognitive shift, it lacks empirical evidence regarding actual behavioral changes, long-term technology adoption, or improvements in actual health service delivery at the community level.

Based on these findings and limitations, future research should employ a more rigorous experimental design, incorporating a control group and a larger, multi-village sample to validate the scalability of the AHHEM model. Furthermore, longitudinal studies are highly recommended to assess long-term knowledge retention and to measure actual behavioral and service-level changes following the intervention. For practical implementation, local health authorities and policymakers should consider integrating the conceptual harmonization modules of the AHHEM into routine cadre training programs. However, to ensure that this cognitive readiness translates into sustained behavioral change, these educational interventions must be coupled with continuous, long-term mentoring and practical support in the field.

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