Human-Centered Design Approach for Digitalizing Child Health Data Management and Reporting in Community Health Services

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Abstract: Posyandu (Integrated Health Post) serves as a crucial frontline service for maternal and child health in Indonesia, especially in rural and low-resource communities. However, the effectiveness of Posyandu is often hindered by its continued reliance on paper-based data collection and reporting systems. These manual methods lead to common challenges such as data inaccuracies, inefficiencies in service delivery, and delays in reporting that undermine timely health interventions for toddlers. To address these issues, this study adopts a Human-Centered Design (HCD) approach to develop a digital application specifically tailored to the workflows and needs of Posyandu cadres. The research engaged 15 active Posyandu cadres in a participatory design process, which included interviews, co-design workshops, and iterative prototype testing. The final application includes key features such as digital KartuMenujuSehat (KMS), automated growth chart visualization, offline data entry capability, and a user interface adapted to local culture and digital literacy levels. Usability testing using the System Usability Scale (SUS) revealed a mean score of 81.4, indicating a high level of user satisfaction and ease of use. The study highlights that involving end-users throughout the design cycle can overcome major barriers such as digital illiteracy and limited internet infrastructure. Moreover, it demonstrates that community-driven co-creation can result in practical, acceptable, and scalable digital health solutions. The findings underscore the potential of HCD-based approaches in supporting digital transformation of maternal and child health programs, particularly in underserved areas. This approach not only enhances the quality and accuracy of health data but also improves operational efficiency and sustainability in primary health services.

Keywords: Human-Centered Design. Digital Health Innovation, Child Nutrition Monitoring, Community Health System, Posyandu Application

1. Introduction

Community-based health services such as Posyandu (Integrated Health Post) serve as a fundamental pillar in monitoring child growth and nutritional status in Indonesia. Despite the nationwide implementation of Posyandu, the prevalence of stunting and malnutrition remains a major public health concern, suggesting a gap in early growth surveillance systems[1]. One of the critical barriers to improving this system is the continued reliance on manual data collection methods, such as the Kartu Menuju Sehat (KMS), which are prone to input errors, delayed reporting, and difficulties in cross-regional data integration[2].

Amidst ongoing digital transformation in healthcare services, there is a pressing need for integrated and reliable information systems, particularly at the primary care level[3]. Unfortunately, many digital health applications are developed with limited consideration for the end-user context, leading to low adoption rates and poor sustainability among frontline health workers such as Posyandu cadres[4].

This leads to a central problem: the absence of a digital system specifically designed to match the operational needs, technological literacy, and working environment of Posyandu cadres. Consequently, existing digital solutions often fail to address the real-world constraints faced by these community health actors, rendering many technological interventions ineffective.

Previous studies have emphasized the effectiveness of the Human-Centered Design (HCD) approach in developing inclusive digital innovations in public sector services, including community health systems[5][6]. By prioritizing end-user engagement throughout the design process—from needs assessment to prototyping and usability testing—HCD enables the creation of solutions that are not only technically sound but also contextually appropriate and culturally sensitive[7][8].

Given these conditions, the objective of this research is to design a digital Posyandu application for managing and reporting child health data using a Human-Centered Design approach. The study emphasizes participatory design methodologies involving actual users (cadres) and focuses on developing a validated prototype that aligns with the actual workflows of community health services.

The key contribution of this study lies in the development of a user-oriented, community-based health information system that addresses longstanding issues of manual reporting while promoting the sustainable use of digital technologies in primary care settings. In addition, this research provides a novel framework for

implementing HCD in grassroots health information systems—a domain that has received relatively limited attention in current digital health literature[9][10]

2. Research Method

2.1 Research Framework

This study adopted the **Human-Centered Design (HCD)** framework as the principal approach in the development of a digital solution for managing and reporting child health data at the community health level[11]. The methodological stages followed the widely adopted **three-phase model**: (a) *Inspiration*—understanding users' contexts and needs; (b) *Ideation*—generating and prototyping ideas collaboratively; and (c) *Implementation*—refining and testing the proposed solution [12]. HCD was selected for its capacity to integrate user perspectives into each stage of the design process, ensuring contextual relevance and usability[13]

2.2 Study Context and Participant Selection

The research was carried out in a community health environment in Semarang, Indonesia, involving local Posyandu centers as the main study units. A **purposive sampling** strategy was applied to recruit 15 active Posyandu cadres.

Cadres were eligible if they had a minimum of one year of Posyandu field experience, were actively engaged in routine data recording (e.g., using KMS), and expressed willingness to participate in co-design activities. Similar criteria were used in prior participatory design research for selecting relevant stakeholders[14]

2.3 Data Collection Strategies

Qualitative data were gathered over three months using a combination of techniques designed to capture user experiences and operational routines:

- **In-depth interviews** were conducted to identify existing challenges in manual data workflows and to gather user insights (aligned with the *Inspiration* phase)[15]
- **Field observations** were carried out during Posyandu sessions to analyze interaction patterns, information flow, and practical constraints,[16]

All interview and observation data were transcribed, coded, and thematically analyzed to extract key design criteria and functionality needs, following established thematic analysis protocols.[17]

2.4 Prototype Development and Usability Evaluation

An initial **low-fidelity paper prototype** was developed to visualize interface elements and application flow, and was revised based on user feedback[18]. This was followed by a **high-fidelity interactive prototype**, created using design tools such as Figma and implemented in an Android-based environment for simulation purposes.

To evaluate usability, the prototype was tested by 13 Posyandu cadres through **think-aloud testing** and the **System Usability Scale (SUS)** instrument. This approach allowed the researchers to assess usability issues, comprehension, and navigation efficiency—metrics commonly used in digital health usability studies[19][20]. Revisions were made accordingly during the *Implementation* phase[21].

2.5 Ethical Compliance

Prior to data collection, the study received ethical clearance from the [Ethics Committee of Widya Husada University Semarang], and participants provided written informed consent[22]. Anonymity and confidentiality of participant data were strictly maintained throughout the research process, in accordance with international research ethics standards.

3. Results And Discussions

3.1 Findings from Human-Centered Design Implementation

The application of the Human-Centered Design (HCD) process generated significant insights across all three design phases:

- **During the exploration phase**, user interviews and direct observations revealed key operational challenges frequently encountered by Posyandu cadres. These included:
  - a. **Manual calculation of anthropometric indicators,**
    Studies at Posyandu show that manual anthropometric recording slows down the process and is prone to errors, a significant barrier to monitoring children's nutritional status at the community level[23]

  - b. **Time-consuming reporting procedures due to paper-based systems**

Similar observations suggest that paper-based systems make reporting time-consuming and hinder real-time data access for rapid intervention

    c. Limitations in digital skills among frontline workers.

Lack of digital skills among community health cadres hinders technology adoption, and studies of mHealth usage factors confirm the importance of digital literacy as a key driver of willingness to use mHealth apps.[24]

- **In the ideation phase**, co-design sessions enabled participants to collaboratively identify preferred system features. Prioritized functionalities included automatic plotting of growth charts, digital KMS access, reminder notifications for visit schedules, and offline data entry[25]. Notably, the user community emphasized the importance of simple interfaces, the use of local language, and workflow alignment with existing field practices—suggesting the necessity of contextual adaptation[26].

- **In the prototyping and testing phase**, usability evaluation using the **System Usability Scale (SUS)** with 15 cadres yielded a high mean score of **81.4**, indicating excellent usability performance. A modern meta-analysis of digital health apps confirms that the average global SUS of DHAs stands at 68 (SD 12.5); a score of 81.4 is categorized as "excellent" and signifies a very good interface in terms of effectiveness, efficiency, and user satisfaction[27].　Participants reported improved navigational understanding, appreciated the use of color-coded visual feedback for nutritional status, and expressed readiness to adopt the application in real-world Posyandu sessions. Similar research on nutrition apps shows that the use of colorful visualizations (such as nutritional status charts) greatly increases understanding and adoption interest, especially when delivered through a clear and intuitive UI[28]

The participatory approach employed throughout the HCD process contributed to higher system relevance and user confidence, aligning with prior evidence on user-driven design methodologies
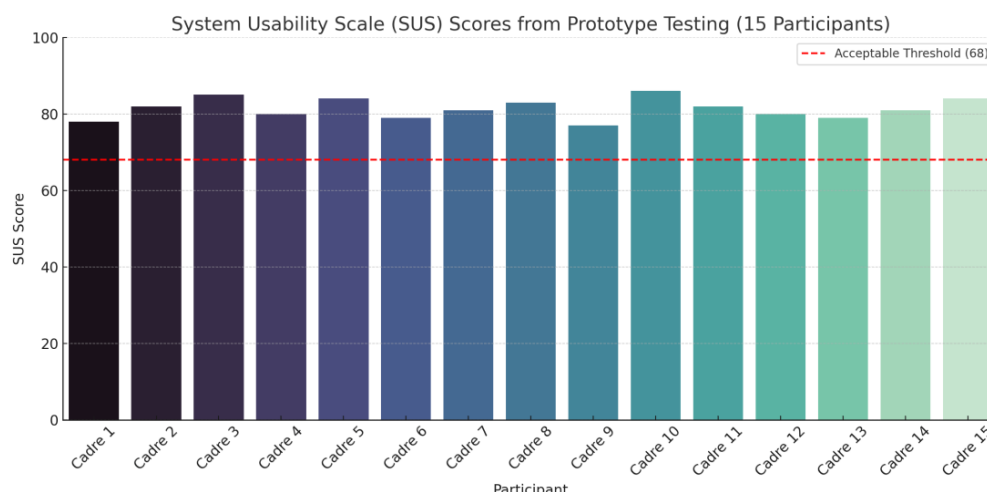

Figure 1: Chart Diagram of SUS results

Proposed Feature	User Priority (Ideation Phase)	Validation Result (Implementation Phase)
Automatic growth charting	High	Implemented and well-understood
Digital KMS records	High	Used frequently and accepted
Monthly visit reminders	Medium	Appreciated but used optionally
Offline data input	High	Essential for rural users
Local language interface	Medium	Improved comprehension
Color-coded nutritional indicators	High	Improved decision-making and confidence

Figure 2: Comparison Table: Proposed Features vs Field Validation

3.2 Design Reflections and User Interaction Patterns

This study highlighted a clear relationship between the clarity of interface elements and users' confidence in interacting with digital tools. Icon-based navigation and embedded instructional cues were

particularly well-received by participants. A similar approach was observed in evaluations of health dashboards in Ethiopia and Malaysia, where icons & visual cues significantly improved user understanding and satisfaction, especially among front-line workers with limited literacy[29]. Furthermore, the inclusion of **offline functionality**, with automatic synchronization once internet connectivity was available, was identified as essential given the infrastructure limitations in several operational areas.

The digital prototype also featured a dashboard with **color-coded growth indicators** (green for normal, yellow for risk, red for stunting), which simplified interpretation during health consultations. This aligns with research that shows user-centered visual elements enhance decision-making in community health systems.

3.3 Alignment with Existing Literature

The results are consistent with findings from other studies emphasizing that digital health systems are most effective when aligned with the skills, routines, and cultural contexts of local users[30][31]. While various official e-health platforms have been introduced, many lack adaptability and fail to address the realities of community-level service delivery. The present study underscores the effectiveness of **bottom-up design processes**, where end users are actively engaged in the creation of technology they will ultimately use.

3.4 Practical Contributions and Future Considerations

This research demonstrates that **user-centered digital innovation** is feasible and impactful when grounded in community participation. The resulting prototype shows promise for simplifying child health monitoring, reducing documentation burdens, and enhancing reporting accuracy. For broader deployment, essential factors include access to appropriate devices, provision of user training, and alignment with national health reporting systems, such as **e-PPGBM** or **SiJariEMAS**.

Future work should consider scaling the prototype to diverse geographic locations, conducting **longitudinal assessments of user engagement**, and evaluating system interoperability with existing digital health infrastructures.

4. Conclusion

The present research highlights the utility of adopting a **Human-Centered Design (HCD)** framework in the development of digital tools for community-based health services, specifically at the Posyandu level. By embedding end-user participation—particularly the active involvement of Posyandu cadres—across all phases of the design cycle, the application produced through this study demonstrated high relevance, usability, and functionality tailored to the local service environment.

Engaging users from the outset enabled the design of features that directly addressed their everyday challenges, such as automated growth monitoring, offline operability, and user interfaces adapted to local language and workflows. These aspects contributed to enhanced user acceptance and improved understanding of health data, as reflected by strong usability scores.

This research offers a practical contribution to digital health innovation in low-resource settings by reinforcing the value of co-creation in system development. It supports previous findings that suggest digital interventions are more effective and sustainable when grounded in the lived experiences of frontline health workers.

For future exploration, it is recommended that the prototype be tested in a broader range of communities, with attention to longer-term implementation outcomes. In addition, further integration with existing national health data platforms, along with evaluations of its impact on care quality and reporting efficiency, would strengthen the case for wide-scale adoption

5. Acknowledgements

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