Diffusion of Innovation Analysis of The Sayang Warga App in Surabaya's PHBS Program

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ABSTRACT

***Background**: The Surabaya City Government launched the Sayang Warga (Citizens' Love) application as a means of real-time data collection and reporting of PHBS indicators to support the Clean and Healthy Living Behavior (PHBS) Program. However, its implementation faced various technical and non-technical obstacles that impacted data quality. **Objective**: This study aims to identify the implementation challenges of the Sayang Warga application and analyze their root causes and alternative solutions based on the Diffusion of Innovation Theory perspective. **Methods**: This qualitative descriptive study used a health information system evaluation approach at the Surabaya City Health Office and involved seven informants, including Puskesmas heads, officers, and health office staff. Data were collected through interviews, observations, and document reviews and were analyzed thematically. Problem prioritization used the USG method with FGDs, followed by fishbone analysis and interpretation using the Diffusion of Innovation Theory. **Results**: The study identified obstacles in implementing the "Sayang Warga" application within the Surabaya City PHBS program, particularly related to complexity, compatibility, observability, and the innovation diffusion stages of knowledge and confirmation. The main issue was the absence of a feature to distinguish between inputted and non-inputted data, leading to potential duplication. **Conclusion**: A system update is recommended to include an automatic data cleansing feature and a warning notification for duplicate inputs or unsaved data. This innovation is expected to enhance data validity, efficiency, and overall quality of PHBS reporting, thereby supporting the optimization of the Surabaya City health information system.*

***Keywords**: Diffusion of Innovation Theory, Healthy Lifestyle, Health Information System, Sayang Warga Application*

INTRODUCTION

One of the most important things that can be done to improve the Human Development Index (HDI) is to improve health. To make public health better, people need to change their behavior to support a healthy lifestyle, not merely rely on access to health services (Suryati, Murni and Impian, 2025). Since 1996, the government has developed a strategy for promoting clean and healthy living behaviors at the household level. The program includes ten indicators: childbirth attended by health workers, regular weighing of infants, handwashing with soap, use of healthy toilets, consumption of fruits and vegetables, daily physical activity, and smoking cessation(RI, 2011).

These behavioral components represent essential determinants of health aligned with the *salutogenesis* perspective, which emphasizes strengthening resources that enable individuals and families to maintain and enhance overall well-being.

Surabaya is a leader in digital transformation, receiving recognition as the most innovative city in the 2022 Innovative Government Award (IGA) for its consistent implementation of digital governance and innovative public services (Elaine, 2022). To support the implementation of clean and healthy living behaviors (PHBS), the Surabaya City

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Government launched the Sayang Warga (Saving Citizens) application, a web-based innovation for data collection by neighborhood association (RT) administrators and Great Surabaya Cadres (KSH). This application enables real-time reporting of PHBS indicators and is integrated with the Surabaya City Health Office (Fatimah, 2023).

This digital reporting mechanism strengthens health promotion by improving the timeliness and accuracy of community health data, enabling more responsive interventions that support healthy behavior adoption. This aligns with the Minister of Health's directive that digitalization in health programs must be accessible to stakeholders and beneficial to the community (Kemenkes, 2021). However, despite its potential, the field implementation of Sayang Warga faces several challenges, such as data duplication, repeated data entry, weak integration across reporting levels, and limited public participation. These issues have led to a decline in data validity, reliability, completeness, and timeliness.

These constraints hinder the development of supportive environments that enhance individuals' sense of coherence which is a core concept in salutogenesis, because inconsistent data reduce communities' capacity to make informed health decisions. Although the Sayang Warga application plays a strategic role in supporting health data digitization and PHBS implementation, research related to this innovation remains limited. Existing research primarily focuses on the system's technical effectiveness and the functional roles of cadres, with a paucity of studies analyzing the adoption, acceptance, and diffusion of this application from a theoretical perspective. In particular, studies linking Sayang Warga implementation to the Diffusion of Innovation Theory are still limited. This leaves a gap in understanding how innovation characteristics, communication channels, adopter categories, and diffusion stages influence the success of applications in community-based health systems.

The novelty of this study lies in addressing this gap by integrating qualitative analysis, health information system (HIS) evaluation, and the Diffusion of Innovation framework to explore adoption dynamics within a community-centered digital health system. The diffusion of innovation theory seeks to explain how new concepts, technologies, or practices are disseminated and accepted among members of a society (Rogers, 1983). This theory explains that the successful diffusion of an innovation is influenced by the innovation's characteristics (relative advantage, compatibility, complexity, trialability, and observability), communication channels, adopter categories, and the stages of the diffusion process (Mailin *et al.*, 2022). Understanding these factors is crucial in health promotion because the adoption and maintenance of healthy behaviors depend on how effectively innovations are communicated, perceived, and integrated within communities.

It is imperative to close this gap since the sustainability and success of digital health innovations depend not only on the technical infrastructure but also on how well they are integrated into the larger healthcare system. Users, particularly health professionals and cadres, must embrace and incorporate them into their everyday routines. The Sayang Warga innovation runs the risk of getting stuck at the implementation phase and failing to gain complete user acceptance and community-level impact if the diffusion process is not fully understood. Proper adoption would support a salutogenic approach by enabling individuals and communities to access comprehensible, meaningful, and manageable health information.

As a result, this research is urgently needed to identify implementation issues of the Sayang Warga application, analyze the underlying causes of these challenges, and propose solutions based on the framework of the Diffusion of Innovation Theory. This study hopes to advance the theoretical understanding of digital innovation adoption in public health while simultaneously enhancing its practical application in community health program digital transformation initiatives. The insights generated will support more effective health promotion strategies, strengthen community participation in PHBS, and create a healthier environment consistent with salutogenic principles.

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METHODS

This study examined program implementation issues, data quality barriers, and user adoption challenges related to the Sayang Warga health information system, ensuring alignment between the evaluation method, results, and discussion. The study employed a qualitative descriptive design to examine how the health information system operates within the context of digital health services in Surabaya City. The research focused on understanding how the Sayang Warga application is implemented as part of the city's health information infrastructure, how users interact with it, and the factors that facilitate or impede its effectiveness in supporting community health programs. The research applied a health information system evaluation approach, which emphasizes an in-depth examination of system performance from multiple perspectives.

This evaluation method is used to assess whether a health information system effectively supports program implementation. It analyzes three key dimensions: (1) the technical dimension, which covers system functions, the data processing accuracy, and system integration; (2) the organizational dimension, which focuses on management support, policy alignment, and workflow suitability; and (3) the behavioral or user dimension, which examines user skills, system acceptance, and user interaction. Together, these dimensions provide a comprehensive understanding of how technology, organizations, and users interact in the implementation of a digital health system.

Using this evaluation approach, the study analyzed the implementation of the Sayang Warga application as part of Surabaya's digital health system. The assessment explored technological challenges in data processing, organizational barriers to coordination, and behavioral factors influencing user adoption. The research was conducted at the Surabaya City Health Office and involved key informants, including the Head of the Health Promotion and Community Empowerment Division, heads of Community Health Centers (Puskesmas), health promotion staff, and community health cadres.

Data were collected through in-depth interviews, observations of application use, and review of program reporting documents related to the Clean and Healthy Living Behavior (PHBS) program. To identify and prioritize problems, the study used the USG (Urgency, Seriousness, Growth) method, followed by focus group discussions with informants to validate and refine the identified issues. A fishbone diagram was then used to identify root causes of the most dominant problems by decomposing complex issues into their contributing factors. Finally, the findings were interpreted using the framework of innovation adoption which included examining innovation characteristics, communication channels, adopter categories, and stages of diffusion to understand how the Sayang Warga application spreads and is accepted among its users.

RESULTS AND DISCUSSION

The analysis results indicate a number of issues affecting the data quality and effectiveness of the Sayang Warga application as a health information system. These findings are presented in four main sections: identification of the main problem, problem analysis based on the diffusion of innovation theory, and prioritization of problems using the USG method. A root cause analysis using a fishbone diagram was also conducted.

Problems with the Sayang Warga Application Implementation

Seven significant challenges to the implementation of the Sayang Warga were found in this research. A request to become the health information system for the PHBS program in Surabaya.

Table 1. Key Problems Reported by Cadres and Health Officers

No	Problem Identified	Impact on Data Quality	Corresponding Innovation Attribute
1.	Data entered not saved	Loss of records, repeated entry	Complexity
2.	Re-entry of identity data required	Longer reporting time	Complexity

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No	Problem Identified	Impact on Data Quality	Corresponding Innovation Attribute
3.	No distinction between surveyed vs. unsurveyed data	Duplication	Complexity
4.	Cadres cannot access cross-area data	Low validation capability	Compatibility
5.	No filter between old and new data	Manual sorting burden	Compatibility
6.	Cannot remove deceased citizen data	Outdated information	Observability
7.	Progress only visible week 2	Low visibility, weak feedback loop	Observability

Analysis Based on Diffusion of Innovation Theory

Characteristics of Innovation

1. Complexity (Problem 1) – Inputted data often fails to save, requiring cadres to re-enter it. This increases the workload and raises the perception that the application is difficult to use.
   Frequent failure of data to save is consistent with findings in digital HIS systems where unstable input processes reduce data completeness (Organization, 2015)
2. Complexity (Problem 2) – Cadres must re-enter community identity data every period, even though the data has not changed. This prolongs input time and reduces reporting efficiency.
   Re-entering identity data each period reflects poor system usability, which is a leading cause of reporting burden in low-resource digital health systems (Kim *et al.*, 2022).
3. Complexity (Problem 3) – The lack of a distinguishing feature between surveyed and unsurveyed data creates the risk of duplicate input, complicating the reporting process, and reducing data accuracy.
   Duplication is a common HIS problem when validation features are limited, as noted in digital reporting and community-based health system studies (Aisyah *et al.*, 2025).
4. Compatibility (Problem 4) – Cadres cannot access cross-regional data, which is often needed for validation. This limitation makes the application less suitable for the operational needs of cadres in the field.
   Restricted cross-area access reduces workflow efficiency, aligning with evidence that interoperability is a key determinant of HIS success (Torab-Miandoab *et al.*, 2023).
5. Compatibility (Problem 5) – Health center managers have difficulty distinguishing between old and new data because there is no automatic filter feature, requiring manual report processing.
   Manual sorting of old/new data is a barrier commonly observed in decentralized reporting systems
6. Observability (Issue 6) – Data on deceased individuals cannot be removed from the system, resulting in outdated information and making it difficult to accurately monitor reporting results.
7. Observability (Issue 7) – New data input results only appear in the second week after the period changes, making it difficult for users to directly observe the application's benefits.
   Delayed data feedback weakens user confidence in digital tools, as found in systematic reviews of mHealth implementations and WHO guidance on digital health monitoring (Odendaal *et al.*, 2020).

Communication Channels

In the implementation of the Sayang Warga application, the effectiveness of communication channels remains limited. The application’s purpose, benefits, and usage have not been systematically communicated to all user levels. Newly joined cadres often do not receive adequate technical training, so they only learn informally from fellow cadres (peer learning). This situation creates misunderstandings about how to operate the application, particularly in overcoming technical issues such as failed data saves and duplicate input.

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Adopter Categories

In the implementation of the Sayang Warga (Citizens' Health) application in Surabaya, adopters can be classified into five categories: innovators, early adopters, early majority, late majority, and laggards.

1. Innovators
   This group consists of developers and several community health center (Puskesmas) cadres and officers who first tried the application during the initial trial phase. They have a strong interest in digital innovation and play a crucial role in providing initial input for system improvements, but their numbers are still limited, making them unable to drive widespread adoption without structural support from the Health Office.
2. Early Adopters
   This group consists of community health center (Puskesmas) cadres and officers who quickly adapted to the digital reporting system, recognizing the benefits of efficient real-time PHBS reporting. They act as opinion leaders in the field by helping other cadres understand how to use the application. However, limited follow-up training and a lack of mentoring have prevented them from optimally expanding the diffusion of the innovation.
3. Early Majority
   This group includes cadres who began using the application after seeing the benefits and success of early adopters. They require concrete evidence of the application's ease of use and effectiveness before committing to regular use. Technical constraints such as unsaved data and difficulty distinguishing between new and old data reduce this group's motivation to adopt consistently.
4. Late Majority
   This group tends to use the application because of obligations from their department or superiors, rather than because they are aware of its benefits. They exhibit low levels of trust in the system due to previous negative technical experiences. Low observability and a lack of positive feedback hinder the adoption process in this group.
5. Laggards
   This group consists of cadres or officers who are still reluctant to use the application and prefer manual recording methods. Contributing factors include limited technological capabilities, poor internet access, and old habits that are difficult to change. They represent a major challenge to achieving widespread adoption of the Sayang Warga application.

Diffusion Stages

1. Knowledge
   Because cadres and officers did not undergo adequate testing, their understanding of the application's functions and operation remained limited. As a result, many technical challenges were only identified after the application was fully used. This indicates that the user learning process for the innovation was insufficient in the early stages of diffusion.
2. Persuasion
   Difficulty in using the application (issues 1, 2, and 3) and inconsistency with user needs (issues 4 and 5) reflect a combination of high input complexity and feature misalignment with field requirements. These conditions fostered negative attitudes toward the application. Instead of feeling that the application made their work easier, they perceived it as increasing administrative workload. This weak acceptance slowed the diffusion process in the field.
3. Decision
   Although the application offered the benefit of real-time reporting, technical glitches and data storage failures undermined user confidence in consistent adoption. Some cadres tended to return to manual methods, perceived as more stable and reliable.
4. Implementation
   During the implementation phase, cadres and officers faced technical challenges such as the inability to delete deceased data (issue 6) and a two-week delay in viewing input results (issue 7). Furthermore, community health centers struggled to differentiate between old and new data (issue 5), leading to inefficient and duplicative reporting workflows.
5. Confirmation

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Because input results were only visible after two weeks, users struggled to obtain prompt feedback that would strengthen their belief in the application's usefulness. This weakened cadres' and officers' commitment to maintaining long-term application use and further slowed the diffusion process at the field level.

Problem Prioritization

Based on the priority scoring results of seven problems using USG method, the following results were obtained:

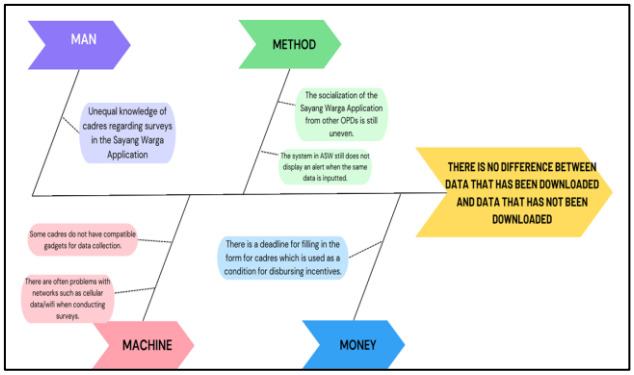
Table 2. Distribution of Respondents' Digital Health Literacy Levels

Problem	U	S	G	Total Value	Priority Of The Problem
Data entered by cadres often fails to be saved from the system	26	27	28	81	1
Community identity data must be refilled each period	25	26	26	77	3
The system does not yet limit the data that has or has not been surveyed	24	25	23	71	6
Cadres cannot view data for areas other than the area they are assigned to	21	20	22	63	7
There is no difference between data that has been downloaded and data that has not been downloaded	27	26	27	80	2
The data of deceased individuals cannot be deleted by the system	26	25	25	76	4
New data progress appeared in the second week.	24	21	27	72	5

It was found that the number one priority problem, ranked 7th, was that data entered by cadres was often lost or not retained in the health information system (Sayang Warga Application) for the PHBS program for households at the Surabaya City Health Office. However, based on further FGDs with informants, it was determined that the more critical problem in the health information system (Sayang Warga Application) was that the survey data in the application did not differentiate between data that had been retrieved and data that had not. This led to repeated duplication of data during download and processing activities.

Problem-Causing Analysis

The problem-causing analysis was conducted using the Fishbone diagram method. The fishbone analysis was conducted through discussions with staff involved in the household-level PHBS program. The following are the results of the problem analysis related to the health information system for the household PHBS program at the Surabaya City Health Office in 2025 as examined through the fishbone diagram:



Source: Primer Data. 2025

Figure 1. Fishbone Diagram of Health Problems in the PHBS Program for Household Structure

Based on the results of the analysis of the causes of the problem using a fishbone diagram, the causes of the problem were identified based on the following factors:

1. Man

   Problems related to human resources, particularly among cadres, primarily lie in their low data collection skills. Many cadres lack a common understanding of the technical standards for entering data into the application. Knowledge about criteria for healthy latrines, decent housing, and other aspects of

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the PHBS survey in the Sayang Warga application is also unequal. Some cadres often forget to save their data after conducting the survey. This situation impacts the low quality and consistency of the collected data.

Based on the diffusion of innovation theory, these problems indicate a high level of complexity in the innovation characteristics, making the application difficult to adopt. This obstacle also indicates that the knowledge phase of the diffusion process has not been optimally achieved because the socialization and training processes have not been able to reach all cadres equally.

According to the WHO, empowering communities in HIS implementation requires strengthening human resource capacity through training. With adequate skills, health cadres and health workers can manage data appropriately, support decision-making, and ensure more inclusive and empowered community participation in the health information system (Organization, 2015).

2. Method

In terms of methods, obstacles arose because the socialization of the Sayang Warga application had not yet reached all cadres, especially those who had just joined. A lack of technical understanding from the start led to numerous errors when entering data. Furthermore, the same data was often entered in subsequent months, even though for indicators such as PHBS, the survey was only conducted once per year for each head of household. The lack of validation features or automatic warnings in the application system meant that the same data could be entered repeatedly without cadres realizing it.

Based on the diffusion of innovation theory, the method-related obstacles to using the Sayang Warga application included low observability because the application's benefits were not immediately apparent when duplicate data occurred, and high complexity due to the lack of validation features, which required cadres to repeatedly input data. In terms of adopter categories, new cadres who tend to fall into the late majority or laggards group are more vulnerable to difficulties than early adopters who adapt more quickly. This obstacle is also influenced by ineffective communication channels, where technical information from the Health Office and community health centers is not evenly distributed, resulting in varying data quality. From a diffusion perspective, some cadres are still stuck at the knowledge stage because they have only been introduced to the application, while others who are already at the implementation stage continue to face obstacles due to the lack of support for validation systems.

Automatic data validation is crucial in digital health applications because it ensures that the data used in the system is accurate, complete, and timely. An automated validation process can detect data anomalies from multiple heterogeneous sources, automatically validate the data's accuracy, and report any discrepancies identified. This is crucial for maintaining the quality of data used in clinical decision-making and health management, ultimately improving the reliability and effectiveness of digital health applications (Ebbers *et al.*, 2023).

3. Machine

Technical or equipment issues were also quite significant. Some cadres lacked adequate devices (gadgets) for digital data collection. Typically, cadres initially used paper media containing survey questions, and then re-entered the data into the application once a usable gadget was available. Furthermore, during field surveys, network issues often occurred, such as the poor internet signal or unstable Wi-Fi access. This made it difficult for cadres to input data directly in the field, resulting in potential data loss or delays in reporting. These issues indicate the need for better technological support and application features that can function offline.

Based on the diffusion of innovation theory, technical problems in using the Sayang Warga application indicate low compatibility because the application is not yet suited to the conditions faced by cadres who have limited device and internet access. In terms of adopter categories, this obstacle is

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experienced more by the late majority and laggards, who have limited digital literacy and resources, in contrast to early adopters who are more prepared to adapt. Obstacles are also related to ineffective communication channels in conveying technical solutions, such as alternative offline application usage. From a diffusion perspective, some cadres are still stuck at the implementation stage because technical obstacles hinder smooth reporting, making it difficult for the adoption process to progress to the confirmation stage. This technology-based problem is also in line with research conducted by Irianna Futri and Phaninee Naruetharadho (2025), which states that there are still several weaknesses, such as inconsistent internet connectivity and limited access, which hamper the effectiveness of digital health (Futri and Naruetharadhol, 2025).

4. Money
   From a financial perspective, the initiative raised concerns among cadres about the uncertainty of receiving incentives after data collection. Cadres assumed that if data failed to be input into the system, incentives would not be received. However, problems often occurred, such as data failing to be saved, and so on. This led cadres to re-enter previously entered data. This created a new problem: duplicate data in the system. As a result, the PHBS program officers had to manually sort through the data because there was no filter to distinguish between previously entered and downloaded data and data that had not yet been inputted and downloaded. Cadres require transparency regarding the incentive system so they feel appreciated and motivated to continue reporting data accurately and in a timely manner.
   Based on the diffusion of innovation theory, incentive issues indicate obstacles at the confirmation stage of the diffusion process because cadres lack full confidence that their efforts are valued and recognized by the system. Concerns about non-disbursement of incentives when data is not saved increase cadres' workload by requiring repeated data entry, ultimately leading to duplicate data. This situation is more prevalent among the late majority and laggards, whose motivation is strongly influenced by the certainty of incentives, in contrast to early adopters, who are more innovation-oriented.
   The motivation of health cadres in public health programs can be influenced by various factors, both material and non-material. Material factors such as financial incentives can increase cadre motivation because they provide direct recognition for their efforts. Financial rewards, such as a monthly transportation allowance, have been shown to provide significant motivation for community health workers (Saran *et al.*, 2020).

Alternative Solution Plan

The alternative solution plan was developed based on the analysis of the causes of problems in the implementation of the PHBS program health information system for households in Surabaya City. The details are as follows:

1. Adding a system-generated data cleansing feature, which is expected to resolve the issue of duplicate data.
   With this additional feature, duplicate data can be detected and deleted, leaving only one record. Furthermore, this feature reduces the need for PHBS administrators to manually filter data that has been entered or not entered for analysis.

Adding an alert notification feature, which will provide a warning if a cadre accidentally inputs the same data or forgets to save the surveyed data. This is expected to address the problem of the same data being entered twice and prevent data input failures due to staff who forget to save the data.

CONCLUSION

The priority problem with the Sayang Warga application health information system for residents participating in the PHBS program at the household level in Surabaya City lies in the lack of differentiation between data that has been downloaded or inputted and data that has not. This creates a risk of duplication and reduces data quality. From the perspective of innovation diffusion theory, this problem reflects high complexity and low observability, as

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cadres have difficulty distinguishing data status and do not immediately see the application's benefits.

Furthermore, some cadres are still remaining at the implementation stage without progressing to confirmation due to recurring technical obstacles. Therefore, the solution plan focuses on improving the application system, particularly through the addition of automatic data cleansing features and alert notifications to prevent duplicate input and ensure data is stored correctly, thus supporting the confirmation stage in the diffusion process.

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