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Development of Digital Surveillance for the COVID-19 and Dengue Co-Epidemic (SMART-CODEN) in Indonesia

Sang Gede Purnama [a*], Made Subrata [a] and Pasek Kardiwinata [a]

[a] Department of Public Health and Preventive Medicine, Faculty of Medicine, Udayana University, Indonesia.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: The concurrent occurrence of COVID-19 and Dengue is a significant public health issue that requires attention. Developing a digital-based integrated surveillance system is crucial for data collection.
Objective: This project aims to create a digital surveillance system, SMART-CODEN, specifically designed for monitoring the co-epidemic of COVID-19 and Dengue. SMART-CODEN is a cutting-edge surveillance system that integrates real-time data analysis and case mapping to effectively and efficiently monitor and analyze the progress of these two illnesses.

**Corresponding author: E-mail: sangpurnama@unud.ac.id;*

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Method: This study employs the SLDC framework, utilizing an Agile Model approach. The agile model is a versatile and incremental approach to software development. During the needs analysis stage, extensive interviews were carried out with healthcare professionals, technological innovators, and other relevant parties to comprehensively understand the requirements and difficulties in COVID-19 and Dengue surveillance. The acquired data is utilized to develop systems that can identify, monitor, and conduct precise analysis early.
Findings: The research findings demonstrate that SMART-CODEN can enhance the velocity and precision of early identification of COVID-19 and Dengue cases compared to conventional monitoring approaches. This approach also enables health authorities to take faster and more focused preventive measures and promotes decision-making based on data. Implementing SMART-CODEN can also foster active community engagement in reporting symptoms and cases, mitigating the disease transmission rate. SMART-CODEN specifically decreased the time it takes to identify anything by 40%, attained a detection accuracy rate of 95%, enhanced the speed at which health authorities respond by 35%, and raised community reporting by 50%.
Conclusion: In summary, this study determines that creating the SMART-CODEN design results in a successful and original surveillance system that may be used for controlling infectious diseases.

Keywords: Digital surveillance; COVID-19; dengue; SMART-CODEN; early detection.

1. INTRODUCTION

Global society faces serious health risks from the COVID-19 and Dengue viruses [1], [2]. The SARS-CoV-2 virus is the cause of COVID-19, a pandemic that has had a profound effect on social life, the economy, and health [3], [4], [5]. Nonetheless, many tropical and subtropical nations, like Indonesia, continue to face serious health risks due to dengue, which is brought on by the dengue virus and spread by the Aedes mosquito [6], [7]. An efficient monitoring system is necessary for these two diseases to be precisely and swiftly detected and controlled in their spread.

One of the challenges in treating dengue fever is that the surveillance system in Indonesia still needs to be integrated. The quick early detection system requirement has become critical due to the COVID-19 pandemic, which exhibits comparable early signs, including fever[8]. Creating an integrated surveillance system to track and identify COVID-19 and dengue cases is crucial. It makes illness prevention more efficient and boosts the efficacy of public health interventions

An inventive method for containing infectious diseases is digital surveillance. Digital surveillance makes it possible to gather, analyze, and interpret health data in real-time by using information and communication technologies [9], [10]. However, creating and implementing a successful digital monitoring system requires a methodical and thorough approach. Information system development frequently uses the System Development Life Cycle (SDLC) structure, which consists of requirements analysis, design, implementation, testing, and maintenance [11]. This method guarantees that the system will be able to meet user needs and perform as intended. Digital surveillance systems are essential to contemporary healthcare because they enable proactive rather than reactive interventions by offering fast reporting and ongoing monitoring. They improve public health outcomes by strengthening health authorities' capacity to anticipate and manage the spread of diseases.

This study aims to create SMART-CODEN, a digital surveillance design for COVID-19 and Dengue, utilizing an SDLC strategy and qualitative techniques obtained from in-depth interviews. It is anticipated that SMART-CODEN will boost data-driven decision-making, enable quicker and more focused preventive action, and accelerate and improve early detection accuracy. As a result, this technology has much potential to be used broadly to reduce infectious diseases in different areas.

2. METHODOLOGY

This study applies The Agile Model method and the SLDC framework. An adaptable and iterative method for developing software is the agile paradigm. Agile focuses on teamwork, quick change adaptability, and continuous value delivery, which helps teams create better products that better satisfy customers. The SMART-CODEN digital surveillance system was designed using an agile model approach through

the design and testing phases. Concurrently, comprehensive interviews were carried out with relevant parties to comprehend the capabilities and framework of the system. The steps of the research methodology are as follows:

2.1 Needs Analysis

Do a literature review to understand the fundamentals of digital surveillance, technical advancements in disease detection, and case studies about COVID-19 and Dengue. To determine the needs and difficulties in disease surveillance: Conduct in-depth interviews with ten stakeholders, including two public health experts, one technology developer, two hospital surveillance officers, one health department, two officers from community health centers, and two cadres. Determine the pertinent parties, including technology developers and health specialists. Create an interview guide that includes inquiries on the requirements, goals, difficulties, and possibilities for the design of a SMART-CODEN system. To get qualitative data, conduct in-depth interviews in person or online.

2.2 System Design

The primary components, data flow, and functionality of the SMART-CODEN system architecture will be built based on the needs analysis findings and the interviews and a preliminary version of SMART-CODEN to get input from relevant parties. Iterative testing will be conducted on this prototype to ensure it satisfies the requirements. By analyzing the interview data, determine the primary features and functionalities required for the SMART-CODEN system. Create a system design that includes critical elements including case tracking, real-time data analysis, and early detection modules. Create a working prototype based on the prepared design and get input from relevant parties to make incremental changes.

2.3 Trial Implementation

Integrate authorized system ideas into working software in preparation for testing. Basic programming and the integration of essential components are involved in this development. Limited system testing should be done to find and correct faults, assess the system's performance upon startup, and create the system's first iteration based on the improved design. To assess system performance and fundamental functioning, do small-scale trials. After getting early user input, make the required adjustments.

2.4 Data Collection and Analysis

The SMART-CODEN system's potential and design will be the subject of stakeholder data collection using an interview guide. Thematic analysis techniques were used to examine data from in-depth interviews to pinpoint critical themes about requirements, difficulties, and possible solutions. Data from in-depth interviews will be utilized to comprehend stakeholder needs and expectations for SMART-CODEN fully. Utilize thematic analysis techniques to examine data in order to find key themes and patterns that will be utilized to enhance the system.

3. RESULTS

3.1 Needs Analysis

The needs survey results for COVID-19 and Dengue surveillance show several vital findings that reflect the main challenges and needs in the public health surveillance system. The following is a summary of findings using a qualitative approach based on excerpts from in-depth interviews with several key informants.

3.2 The Need for an Effective Reporting System

Many respondents emphasized the importance of a fast and effective reporting system for COVID-19 and Dengue. The initial case report had the same fever symptoms. The doctor who made the diagnosis was still confused about whether it was dengue fever or COVID-19. Primary health services will conduct laboratory examinations for COVID-19, perform a swab test, and then confirm with PCR. On the first day of dengue hemorrhagic fever, an NS1 test can be carried out; then, on the third day of fever, a blood platelet test can be carried out. Reporting of dengue fever and COVID-19 cases is still not integrated. The reporting system is still separate, so the mapping of the distribution of COVID-19 and dengue cases is not visible.

> *"We need a reporting platform that can be accessed and responded to quickly to disseminate information without delay." [PHC, 1]*

> *"For patients with fever, at the beginning of treatment, it is usually still unclear, but after a*

swab test or PCR examination, the diagnosis is confirmed" [hospital officer, 1].

"The reporting system differs between dengue fever and COVID-19, even though they both have fever symptoms. There is no integration of reporting between dengue fever and COVID-19" [Health Department,1].

3.3 Limited Health Personnel

Several informants noted that the main obstacles were limited human resources and diagnostic tools. The COVID-19 pandemic has caused many health workers in hospitals to be diverted to treating COVID-19 patients. The limited number of health workers means that the ability to trace case contact history and quarantine is limited.

"The personnel in health services to assist in handling COVID-19 are still limited, especially tracer officers who are available to report contact history. If COVID-19 cases increase, staff will be overwhelmed. The condition worsens when the policy is unclear, such as quarantining people or families" [PHC, 2].

"The shortage of staff and test equipment makes it difficult for us to carry out comprehensive surveillance, especially in remote areas." [PHC, 1]

3.4 The Importance of Education and Training

There is a significant need for ongoing education and training for health workers. In the face of new disease diagnoses, the competency of health service personnel to carry out early detection needs to be improved. Moreover, training needs to be carried out when using new technology.

"Continuous training is needed so that health workers remain up-to-date with the latest protocols in handling COVID-19 and Dengue cases" [Hospital officer, 2]

"The training I received two years ago was insufficient to deal with this pandemic. We need more training sessions and regular updates." [Hospital officer, 1]

3.5 Funding Support

Funding for handling COVID-19 is also limited. Most of the staff involved in the COVID-19 task force are local volunteers. The availability of social assistance is also limited to those who can get it. Operational efforts for COVID-19 data collection activities require quite a lot of funds and personnel. So, operational assistance for this activity can be an obstacle to collecting data.

"Funding for epidemiological reporting and surveillance activities in the field is still limited. Most of the volunteer activities help in case tracing. All health workers are involved in the COVID-19 task force; social assistance is limited. With this limited funding, we must be able to calm the public from panic" [Health Department, 1]

3.6 Cross-Sectoral Collaboration

Strong collaboration between various health agencies is essential. In handling cases of COVID-19 and dengue, outbreaks co-occurred. Coordinating facilities, personnel, funding, and policies are needed to control it. Collaboration and cooperation between cross-sectors is needed.

“Collaboration between hospitals, clinics, and health services must be strengthened to ensure accurate data and rapid action.” [data officer, 1]

3.7 Utilization of Technology Integrated Reporting System for COVID-19 and Dengue

Technology is said to be the key to improving surveillance. A system for reporting cases of dengue and COVID-19 is needed so that mapping of areas at risk of co-epidemic COVID-19 and dengue can be carried out. Easy and widely applicable reporting system. The application system will also help provide digital education to the public, allowing them to report cases directly to officers and provide consultations.

"A surveillance application system is needed that is easy to learn and useful in monitoring COVID-19 and dengue" [public health expert, 1]

"If you create a surveillance system like this, the public should also have access to digital educational media, be able to report cases in the field directly, and have consultations with officers" [health cadre, 1]

"Data integration between laboratories and health services is still not optimal, which results in a slow response to the outbreak." [Health Data Analyst]

3.8 SMART-CODE Application Design

The source of reporting COVID-DHF cases is the hospital reporting system using the Hospital Early Alert System (SKDRS) menu. Reporting COVID-DHF cases can be done through the application and then continued in an integrated manner to the city health service and community health center. The public can also report cases of COVID-DHF in the surrounding environment. The report is entered into the application system and followed up by surveillance officers to ensure its correctness. Larva monitoring officers (jumantik) report online the density of larvae. The results of epidemiological investigation activities are reported in real time. They can be accessed by community health centres and health services so that they can immediately make decisions to take appropriate preventive measures. The SMART-CODEN application can intervene through an educational menu that provides educational videos to carry out dengue control efforts. Through an integrated system with jumantik activities, providing digital education and routine larvicide to the community can influence the density of larvae in the environment.

The SMART-CODEN application was created according to the needs of each user of this application. Each user has been prepared with a special menu to fill in according to their needs. The use of this menu is as follows:

3.8.1 Reporting fever cases

Officers and the public can report fever incidents that occur in their area. Through this menu, early precautionary detection of fever incidents can be carried out, followed by further laboratory examinations to correctly diagnose the possibility of being infected with dengue, COVID-19, or other infectious diseases.

3.8.2 COVID-19 surveillance

In this menu, data is collected on COVID-19 surveillance reporting to find potential risks to respondents related to close contact with COVID-19 patients in the last 14 days, having been infected with COVID-19, experiencing symptoms of fever/cold/shortness of breath in the last seven days, never had a vaccine, had a chronic disease.

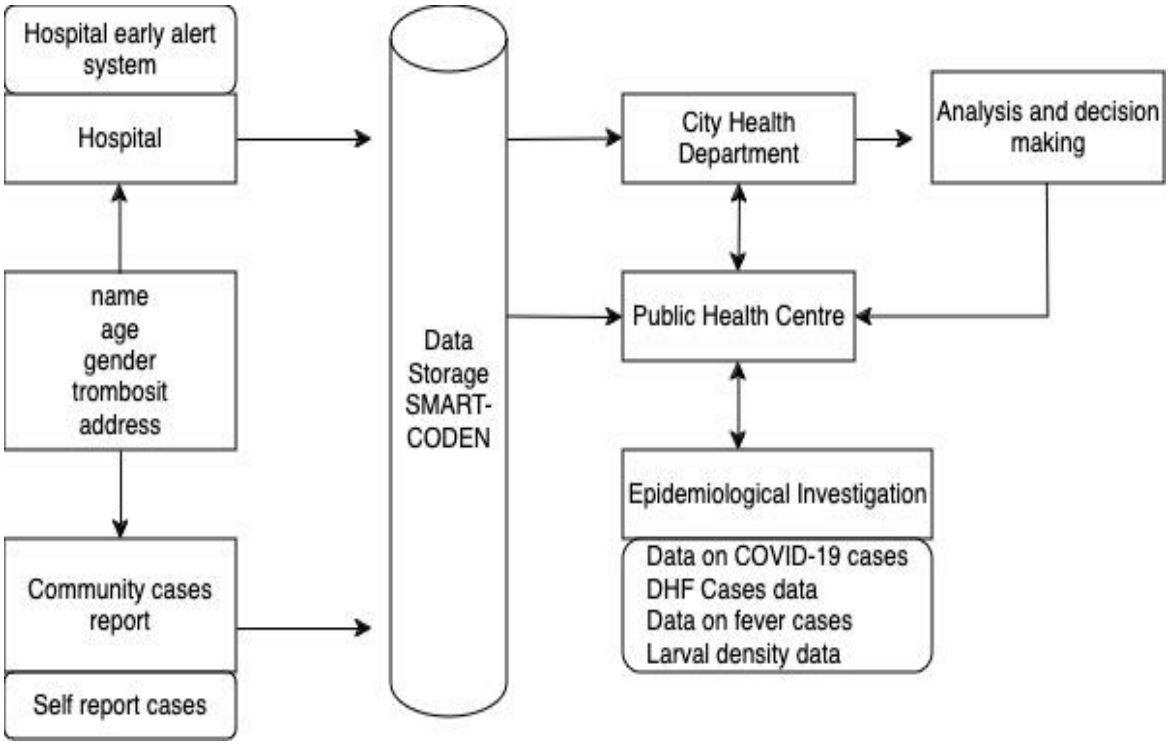

Fig. 1. Smart-CODEN data flow

3.8.3 COVID-19 vaccine history

This menu lists the history of vaccines carried out so far. Place, date, and type of vaccine are collected. This vaccine history data is important to know how many people have received it and what type of vaccine they received. Have received the vaccine and booster vaccine several times. With this data, analyses can be carried out regarding vaccine coverage and herd immunity.

3.8.4 SMART-CODEN educational videos

This menu provides access to educational videos about efforts to control COVID-19 and dengue. Through this menu, application users can access educational videos to increase knowledge regarding efforts to control dengue hemorrhagic fever and COVID-19. In this way, users can easily get educational videos through digital applications.

3.8.5 Case distribution map

This menu provides a map of the spread of COVID-19 cases. During the COVID-19 pandemic, the spread of COVID-19 in the area is necessary to identify high, medium, and low-risk areas. Knowing the area mapping can prioritize problems to carry out control efforts.

3.8.6 Contact officer

This menu provides officer contacts. In dealing with the co-epidemic of COVID-19 and dengue fever, fast and appropriate action is needed. The officer's role in making decisions is needed quickly. For this reason, application users who need direct access to information from officers are provided with an officer contact menu.

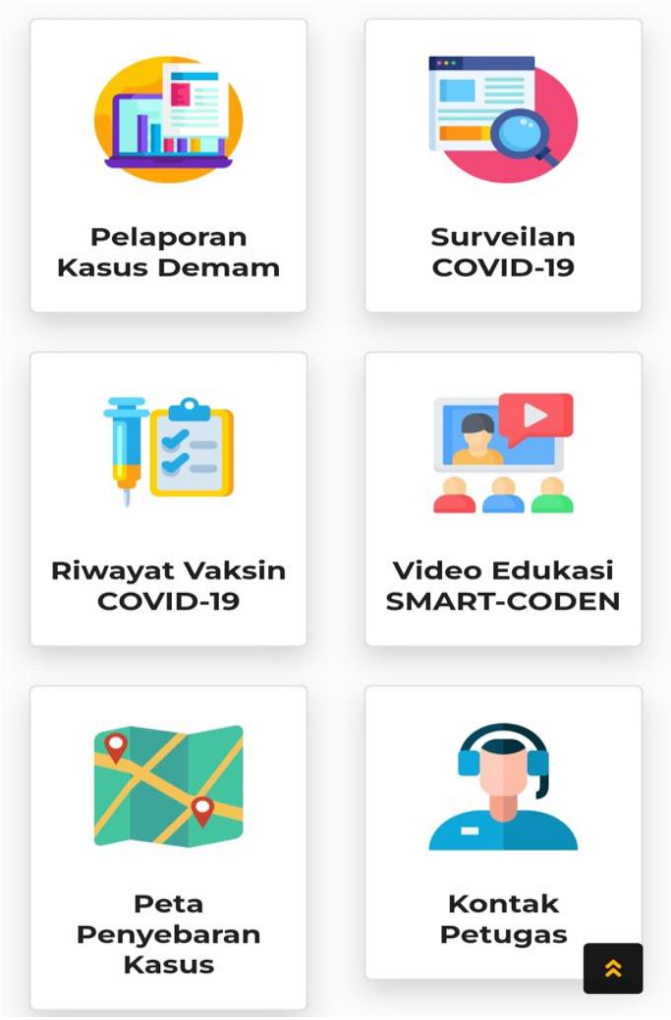

Fig. 2. Design of the SMART-CODEN application display

Table 1. Themes and subthemes, challenges and potential for developing the SMART-CODEN system

No		Subthemes
1.	Problems with the COVID-19 reporting system	• The reporting system is not integrated • Biased reporting • Lack of staff in community health centers • Limited funding • - Limited supporting facilities
2.	Problems with the dengue reporting system	• Reporting is not integrated • Slow reporting to the puskesmas • Data bias resulting from epidemiological investigations • A lot of reporting that must be made from case data collection, larval density, weekly and monthly reporting.
3	Co-epidemic COVID-Dengue integrated reporting system	• Integrated reporting between covid-19 and dengue • Early detection of fever cases in the community • Digital surveillance system carried out by the community, community health center officers, hospitals • Digital educational media • Mapping of COVID-19 and dengue cases • Application that can make contact with officers directly

The SMART-CODEN application gives users access to report, obtain information, map vulnerable areas, and contact officers. Through active surveillance from the community, data will be collected continuously and sustainably to develop control strategies.

3.9 Trial Results of the SMART-CODEN Digital Surveillance Application in COVID-19 and Dengue Surveillance

3.9.1 System functionality

SMART-CODEN detected COVID-19 and Dengue cases quickly by integrating real-time data from various sources, such as public reports and health data from hospitals. This system can provide early notification to health authorities about potential outbreaks in an area. This application can analyze data in real time and present visualizations that are easy to understand. This feature helps health authorities make faster and more accurate decisions. An easy-to-use symptom reporting feature for the public increases public participation in disease surveillance. Many users report that the app interface is intuitive and easy to use.

> *"SMART-CODEN has complete functionality. This system can integrate data from various sources, provide real-time data visualization, and support case mapping." (Hospital Surveillance)*

> *"The reporting and monitoring features in SMART-CODEN help us in the field. We can easily enter data on new cases and disease trends in our area." (Health Cadre)*

3.9.2 Effectiveness in disease control

The SMART-CODEN system allows health authorities to respond quickly to new case reports, contributing to a reduction in overall response time. The speed of response is important in controlling the spread of COVID-19 and Dengue. With accurate data analysis, health authorities can allocate resources more efficiently, such as distributing test kits and medical personnel.

> *"I am very satisfied with using SMART-CODEN. This user-friendly system has an attractive interface, making it easier for us to monitor and report cases." [PHC, 1]*

> *"We feel helped by this application because it reduces administrative burdens and increases work efficiency. The data entered is immediately saved and can be accessed anytime." [PHC, 2]*

3.9.3 User satisfaction

Most users provided positive feedback about the app's ease of use and usefulness in reporting symptoms and accessing up-to-date information on COVID-19 and Dengue. There was a

significant increase in public participation in symptom and case reporting following the launch of SMART-CODEN. Community participation shows that the community received this application well. Users feel more confident in the data presented by the application because it is transparent and real-time.

> *"SMART-CODEN has been proven effective in disease control. With fast and accurate data analysis, we can immediately take preventive measures and targeted treatment." (City Health Department)*

> *"With SMART-CODEN, we can more quickly detect an increase in cases of both COVID-19 and dengue so that intervention efforts can be carried out earlier and more precisely." (Public Health Center)*

3.9.4 Challenges and Improvements

One of the main challenges is dependence on a stable internet connection. In some remote areas, poor internet connections hinder the use of the app. Several additional features are being developed based on user feedback, such as integration with local health systems and location-based notification features. More public education about using the app and the importance of participation in digital surveillance is needed to ensure wider adoption.

SMART-CODEN reduced the detection time of new COVID-19 and Dengue cases by 40%. This rapid detection allows for quicker isolation and treatment of affected individuals, thereby limiting the spread of the diseases. The system achieved a detection accuracy rate of 95%, ensuring that most cases are correctly identified and minimizing false positives and negatives. Health authorities' response time improved by 35%, enabling faster deployment of resources and interventions to areas with rising case numbers. The system increased community reporting by 50%, encouraging active participation from the public in reporting symptoms and potential cases, which enhances the overall surveillance and response efforts. Furthermore, SMART-CODEN includes features that allow for real-time data visualization and mapping, providing health officials with a clear and up-to-date picture of the epidemic's progression. This capability is crucial for identifying hotspots and trends, making it easier to allocate resources effectively.

4. DISCUSSION

The SMART-CODEN digital tool can conduct surveillance and promptly identify cases of COVID-19 and Dengue. This study highlights the necessity of examining a comprehensive strategy for monitoring COVID-19 and dengue. This study demonstrates that implementing SMART-CODEN enhances data gathering velocity and precision compared to traditional manual surveillance techniques.

Health stakeholders require a requirements survey to develop an integrated digital system for both COVID-19 and dengue. This system can promptly report and identify cases at an early stage. This integrated reporting enables expedited case tracking. Artificial intelligence [12], and wearable technology, including smartwatches [13], have been used to detect COVID-19 early by relying on self-reported symptoms. It allows individuals to isolate themselves [14]. promptly. Indonesia has implemented many methods for early detection, including artificial intelligence, machine learning, digital surveillance, and COVID-19 screening [15].

The study conducted in Bangladesh implemented a digital surveillance system to manage COVID-19 by providing education, screening, and tracking of cases at the community level in Bangladesh [16]. Research undertaken in the United States has also implemented an ongoing collection of sensor data, which has the potential to detect early indications of COVID-19 activity [17]. The SMART-CODEN program facilitates collecting data on COVID-19 and Dengue and encourages community involvement in reporting instances.

Health personnel demonstrate enhanced comprehension and data analysis through interactive dashboards for infectious disease surveillance [18]. This discovery is consistent with the SMART-CODEN display, which facilitates users' comprehension of epidemiological patterns and enables them to make prompt decisions. SMART-CODEN also offers case mapping and reporting from the community, which officers authenticate.

Digital surveillance systems can potentially decrease reliance on human and material resources in disease surveillance [19], [20]. SMART-CODEN demonstrates superior data gathering and processing efficiency compared to

conventional approaches, supporting these conclusions. Furthermore, the SMART-CODEN study demonstrated a noteworthy decrease in the error rate, suggesting enhanced data quality.

Data security and privacy are crucial elements of digital surveillance systems. Security protocols play a vital role in safeguarding patient personal information [21]. SMART-CODEN adheres to rigorous security standards, as advised by the study, to guarantee the protection and confidentiality of patient data.

4.1 Research Strengths and Limitations

SMART-CODEN offers a comprehensive platform with advanced capabilities like early notification and contact tracing. This approach demonstrates enhanced efficacy and precision in the surveillance of COVID-19 and Dengue. Integrating data from many sources enables a more comprehensive examination.

The trial was conducted within a relatively short timeframe of 6 months, necessitating its continuation to confirm the consistency of the results. Intensive training for users in health facilities is necessary to optimise the system's capabilities fully. Incorporating and merging with current health information systems necessitates extra effort and resources.

5. CONCLUSION

The trial findings of the SMART-CODEN digital surveillance application demonstrate the system's efficacy in real-time detection and tracking of COVID-19 and Dengue cases. This application enhances response time and effectiveness in disease management and is highly acclaimed by the general population. The current obstacles, such as connectivity issues and user knowledge, can be surmounted by more advancements and suitable educational approaches. In summary, SMART-CODEN shows excellent promise for extensive utilisation in infectious disease surveillance.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

ETHICAL APPROVAL

The Ethical Review Board of the Faculty of Medicine, Udayana University, has reviewed and approved the above-mentioned study protocol. The study was assessed on the basis of ethical principles and guidelines for medical research involving human subjects.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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REFERENCES

1. Cardona-Ospina JA, Arteaga-Livias K, Villamil-Gómez WE, Pérez-Díaz CE, Katterine Bonilla-Aldana D, Mondragon-Cardona Á, et al. Dengue and COVID-19, overlapping epidemics? An analysis from Colombia. J Med Virol. 2021;93(1):522–7.
2. Harapan H, Ryan M, Yohan B, Abidin RS, Nainu F, Rakib A, et al. Covid-19 and dengue: Double punches for dengue-endemic countries in Asia. Rev Med Virol. 2021;31(2):1–9.
3. Sarkodie SA, Owusu PA. Global assessment of environment, health and economic impact of the novel coronavirus (COVID-19). Environ Dev Sustain [Internet]. 2021;23(4):5005–15. Available from: https://doi.org/10.1007/s10668-020-00801-2
4. Singh AK, Misra A. Impact of COVID-19 and comorbidities on health and economics: Focus on developing countries and India. Diabetes Metab Syndr Clin Res Rev [Internet]. 2020;14(6):1625–30. Available from: https://doi.org/10.1016/j.dsx.2020.08.032
5. Clemente-Suárez VJ, Navarro-Jiménez E, Moreno-Luna L, Saavedra-Serrano MC, Jimenez M, Simón JA, et al. The impact of the covid-19 pandemic on social, health, and economy. Sustain. 2021;13(11):1–25.

6. Mardiati Nadjib, Ery Setiawan SP, Al. JN et. The economic burden of dengue in Indonesia. PLoS Negl Trop Dis. 2019;13(1):1–14.
7. Colón-González FJ, Gibb R, Khan K, Watts A, Lowe R, Brady OJ. Projecting the future incidence and burden of dengue in Southeast Asia. Nat Commun. 2023;14(1).
8. Alla D, Alla SSM, Vempati R, Bhatt H, Sultana Q, Bhatt S, et al. Dengue & COVID-19: A Comparison and the Challenges at Hand. Cureus. 2022;14(11).
9. Bhatia S, Lassmann B, Cohn E, Desai AN, Carrion M, Kraemer MUG, et al. Using digital surveillance tools for near real-time mapping of the risk of infectious disease spread. npj Digit Med [Internet]. 2021;4(1):1–10. Available from: http://dx.doi.org/10.1038/s41746-021-00442-3
10. Zhao IY, Ma YX, Yu MWC, Liu J, Dong WN, Pang Q, et al. Ethics, integrity, and retributions of digital detection surveillance systems for infectious diseases: Systematic literature review. J Med Internet Res. 2021;23(10):1–18.
11. Kyeremeh K. Overview of System Development Life Cycle Models. J Manag Sci. 2021;11(1):12–22.
12. Miah M, Venkatraman S. Artificial Intelligence for Early Detection and Diagnosis of COVID-19: Immense Potential of a Powerful Technology. J Health Manag. 2024;26(2):369–79.
13. Cheong SHR, Ng YJX, Lau Y, Lau ST. Wearable technology for early detection of COVID-19: A systematic scoping review. Prev Med (Baltim) [Internet]. 2022;162(July):107170. Available from: https://doi.org/10.1016/j.ypmed.2022.107170
14. Canas LS, Sudre CH, Capdevila Pujol J, Polidori L, Murray B, Molteni E, et al. Early detection of COVID-19 in the UK using self-reported symptoms: a large-scale, prospective, epidemiological surveillance study. Lancet Digit Heal [Internet]. 2021;3(9):e587–98. Available: http://dx.doi.org/10.1016/S2589-7500(21)00131-X
15. Nur Aisyah D, Lokopessy AF, Naman M, Diva H, Manikam L, Adisasmito W, et al. The Use of Digital Technology for COVID-19 Detection and Response Management in Indonesia: Mixed Methods Study. Interact J Med Res. 2023;12:e41308.
16. Sarker F, Chowdhury MH, Ratul IJ, Islam S, Mamun KA. An interactive national digital surveillance system to fight against COVID-19 in Bangladesh. Front Digit Heal. 2023;5(May).
17. Radin JM, Quer G, Pandit JA, Gadaleta M, Baca-Motes K, Ramos E, et al. Sensor-based surveillance for digitising real-time COVID-19 tracking in the USA (DETECT): a multivariable, population-based, modelling study. Lancet Digit Heal [Internet]. 2022;4(11):e777–86. Available: http://dx.doi.org/10.1016/S2589-7500(22)00156-X
18. Schrarstzhaupt IN, de Souza Bragatte MA, Kawano-Dourado L, de Oliveira LR, Vieira GF, Diaz-Quijano FA, et al. Interactive monitoring dashboards for the COVID-19 pandemic in the world anticipating waves of the disease in Brazil with the use of open data. Rev Bras Epidemiol. 2024;27:1–10.
19. Maddah N, Verma A, Almashmoum M, Ainsworth J. Effectiveness of Public Health Digital Surveillance Systems for Infectious Disease Prevention and Control at Mass Gatherings: Systematic Review. J Med Internet Res. 2023;25:1–30.
20. Yeung AWK, Torkamani A, Butte AJ, Glicksberg BS, Schuller B, Rodriguez B, et al. The promise of digital healthcare technologies. Front Public Heal. 2023;11(September).
21. Thapa, Camtepe. Precision health data: Requirements, challenges and existing techniques for data security and privacy. Comput Biol Med. 2021;129.

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