

Enhancing early cervical cancer detection through the mobile-based DEDIKASI application

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Abstract

The incidence rate of cervical cancer in Indonesia remains high; however, it can be prevented through early detection. The study aimed to assess the effectiveness of the DEDIKASI mobile application, a continuation of the Early Warning System (EWS) cancer application for cervical cancer risk assessment in women of reproductive age. Employed a quasi-experimental design with a nonequivalent group posttest-only approach, the research included

388 participants chosen through random sampling. The EWS Application group showed a majority categorized as “Very Suspect” (52.6%), while the DEDIKASI group had the majority in the “High Risk” category (40.7%). ISO 25010 testing revealed an excellent overall score of 92% for the DEDIKASI application, indicating strong functional suitability and usability. The t-test results (p -value = 0.000) indicated that the DEDIKASI application was more effective than the EWS Cervical Ca application in assessing cervical cancer risk. The findings underscore the potential of the DEDIKASI mobile application for improving early detection and risk assessment of cervical cancer in women of childbearing age, offering a valuable tool to address the high incidence rate of cervical cancer in Indonesia.

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Introduction

Cervical cancer is characterized by the growth of abnormal cell clusters in the uterus or cervix. Symptoms of cervical cancer include vaginal discharge with blood and odor, pain during sexual intercourse, pain and blood during urination, bleeding from the vagina after intercourse, and swelling of lymph nodes.^{1,2} According to research in 2020, there were more than 600,000 cases of cervical cancer worldwide, resulting in 342,000 deaths, including cases caused by the human papillomavirus (HPV). The incidence rate of cancer in Indonesia (136.2 per 100,000 population) ranks 8th in Southeast Asia and 23rd in Asia overall.³ The two most common types of cancer in Indonesia are breast cancer and cervical cancer.^{4,5} According to data from the Lampung Provincial Health Office (2022), based on early detection examinations for cervical and breast cancer in Lampung Province in 2022, 266 cases of positive Visual Inspection with Acetic Acid (VIA), 64 suspected cancer cases, and 159 tumors/lumps were found. These figures indicate a decrease in the number of positive VIA cases, suspected cancer cases, and tumors/lumps compared to 2021. The increasing number of cervical cancer patients in Indonesia each year is attributed to a lack of knowledge about early monitoring. Symptoms experienced by early-stage patients are often not significantly bothersome.^{6,7} Consequently, most cervical cancer patients only become aware of their condition when it has reached an advanced stage. Early detection is crucial in preventing cervical cancer in women.^{8,9} The sooner abnormalities in the cervix or uterus are detected, the earlier actions can be taken for treatment. Since every woman is at risk of cervical cancer, all women should adopt preventive measures against this condition.^{10,11} Previous research by Aprina, Titi, and Gustop in 2022 proposed the Naïve Bayes method for early cervical cancer detection.¹² The weakness of the Naïve Bayes method lies in the potential suboptimal performance of its predictions, and the lack of consistent attribute selection in the classification process results in lower accuracy.^{13,14} In a study on the development of a behavioral model for early detection of cervical cancer, Maurida et al.

(2019)¹⁵ found significant differences in all variables in the treatment group and in the two groups, except for the perception of susceptibility variable. Another study by Dianti (2016)¹⁶ conducted research on the comparison of cervical cancer risk based on personal hygiene in women of childbearing age in Surabaya, and the results indicated that a history of changing underwear posed the greatest risk of cervical cancer, emphasizing the importance of maintaining personal hygiene. Several articles, including research by Nasution (2021)¹⁷ on Early Detection of Cervical Cancer in Women of Childbearing Age Using VIA test, have contributed to the development of early detection models. The statistical test results showed a significant influence of health education on women's knowledge about cervical cancer and the VIA Test.

Despite various studies on early detection models and the VIA Test, researchers conclude that the field lacks updates in science and technology. Therefore, the research on the DEDIKASI application (acronym for *Deteksi Dini Kanker Serviks*, or in English, Early Detection of Cervical Cancer) serves as a renewal of the Mobile-Based Early Warning System for Cervical Cancer (EWS Cervical Ca.) in Women of Childbearing Age. This Android-based application aims to simplify the early detection of cervical cancer, provide solutions for appropriate early prevention, and help the public recognize risk factors for cervical cancer in women of childbearing age. The research builds on previous studies and journals in the field of reproductive health, contributing to advancements in science and technology.

The reason researchers use the DEDIKASI application is that, in this new application, researchers have introduced several new

features for patients and health professionals, making it easier to use. This feature includes one application that works according to the problem. Apart from that, the urgency of this research is to look at the phenomenon of the incidence of cervical cancer and the minimum early detection by women of childbearing age so that the DEDIKASI application is a feature that is very easy for women of childbearing age to obtain. They can carry out early detection easily without having to go to health services because this application is connected directly to the health workers closest to the user. The aim of this application is to accurately detect and prevent cervical cancer with the help of experts and health professionals who are part of the DEDIKASI application.

The purpose of this study was to create the DEDIKASI mobile-based model for women of childbearing age and test the effectiveness of the EWS.Ca cervical application compared to the DEDIKASI application in the early detection of cervical cancer risk among users.

Table 1. Range of interpretation criteria.

No	Range of interpretation criteria (%)	Criteria
1	0-20	Very poor
2	21-40	Poor
3	41-60	Fair
4	61-80	Good
5	81-100	Very good

Table 2. Frequency distribution of new features assessment aspects of the DEDIKASI application.

Portability	Strongly agree		Agree		Neutral		Disagree		Total
	n	%	n	%	n	%	n	%	
Adaptability	210	54.1	98	25.2	50	12.9	30	7.8	388
Installability	195	50.2	103	26.5	67	17.2	23	6.1	388
Replaceability	228	58.8	76	19.6	53	13.6	31	8	388

Table 3. Frequency distribution of cervical cancer risk with DEDIKASI application.

Group	Category of cervical cancer risk						Total
	Cautious		High risk		Very suspect		
	n	%	n	%	n	%	
EWS Application	32	8.2	152	39.2	204	52.6	388
DEDIKASI Application	121	31.2	158	40.7	109	28.1	388

Table 4. Comparison of the effectiveness of EWS cervical cancer application and DEDIKASI on user risk factors for application.

Group	Mean	SD	Min	Max	p
EWS Application	59.17	16.970	6	89	0.000
DEDIKASI Application	45.29	16.370	13	82	

Table 5. Comparison of EWS cervical cancer application with DEDIKASI on application usage.

Group	Mean	SD	Min	Max	p
EWS Application	65.12	16.139	33	100	
DEDIKASI Application	75.81	16.295	26	100	

Materials and Methods

This study was a quasi-experimental research with a nonequivalent group posttest-only design approach. The study population included all women of childbearing age. The sample size consisted of 388 participants selected using random sampling. The inclusion criteria for this study were women of childbearing age in Lampung Province, not currently pregnant, willing to be respondents, and not currently sick. The exclusion criteria for this study included women of childbearing age with impaired hearing and vision systems, and those who do not yet have a smartphone.

The research variables consist of the Dependent variable: The DEDIKASI application used and the Independent Variable: Risk factors for cervical cancer. The research was conducted from August to December 2023 in Lampung Province. This research instrument used a questionnaire comprising 14 questions regarding application feasibility tests created by researchers, and validity and reliability tests have been carried out. The research was divided into three stages: Stage 1 included data collection and quantitative data processing, Stage 2 focused on developing a model for early detection of mobile technology-based cervical cancer services for women of childbearing age, and Stage 3 included feasibility testing of The DEDIKASI application, expert workshops, and outreach to identify any model weaknesses. Statistical analysis was carried out using a simulator program to produce The DEDIKASI application model that can be accessed online via mobile devices, providing a tool for assessing the risk of cervical cancer in women of childbearing age. Data analysis included univariate analysis carried out descriptively, and bivariate analysis used the t-test statistical method. This research has been registered for ethical observation with Ethical Review number 190/KEPK-TJK/III/2023.

Results

Univariate analysis

Comparison of ISO software quality assessment between the EWS Ca. cervix application and the DEDIKASI application

The usability assessment of the EWS Ca. Cervix Mobile-Based Application was conducted using the International Organization for Standardization (ISO) 25010 standard. A total of 142 respondents, women of childbearing age, answered 8 questions. These questions were categorized into 2 related to Functional Suitability, measuring the software's ability to provide functions that meet specific needs under certain conditions. The remaining 6 questions pertained to Usability, evaluating how effectively, efficiently, and satisfactorily the product or system can be used by specific users within the context of use. Each question had multiple-choice answers with corresponding scores: Strongly Agree (5), Agree (4), Neutral (3), Disagree (2), and Strongly Disagree (1).

The ISO 25010 calculation results are expressed in the formula:

$$\begin{aligned} \text{Percentage of ISO 25010} &= \frac{\text{actual score}}{\text{ideal score}} \times 100\% \\ &= \frac{4972}{5680} \times 100\% \\ &= 88\% \end{aligned}$$

Subsequently, the questionnaire results are compared with the score interpretation criteria range, as presented in Table 1. The data processing in the ISO 25010 testing, covering functional suitability and usability, indicates that the EWS Ca Cervix application software achieved an overall percentage score of 88%, classifying it as "Very Good" for use based on the interpretation score range (Table 1).¹⁸ The DEDIKASI Mobile-based application underwent usability testing using ISO 25010. The test involved 388 respondents of reproductive-age women who answered 8 questions, including 2 related to Functional Suitability and 6 related to Usability. The ISO 25010 calculation results are presented in the formula:

$$\begin{aligned} \text{Percentage of ISO 25010} &= \frac{\text{actual score}}{\text{ideal score}} \times 100\% \\ &= \frac{22959}{24832} \times 100\% \\ &= 92\% \end{aligned}$$

The results from the questionnaire are then compared with the score interpretation criteria range, leading to the determination that the DEDIKASI application software achieved an overall percentage score of 92%, classifying it as "Excellent" for use based on the score interpretation criteria range (Table 1). In this latest application, new features are identified within the Portability aspect, encompassing the following sub-domains: (a) Adaptability: The average respondents strongly agree, with a count of 210 (54.1%) for this indicator. The testing indicator suggests that the transition from EWS Ca Cervix to the DEDIKASI application can be easily adapted by users, thanks to its new features; (b) Installability: The average respondents strongly agree, with a count of 195 (50.2%) for this indicator. The testing indicator demonstrates easy installation when using the DEDIKASI application; (c) Replaceability: The average respondents strongly agree, with a count of 228 (58.8%) for this indicator. The testing indicator indicates that the DEDIKASI application can seamlessly replace the EWS Ca Cervix application with the implementation of its new features (Table 2).

Frequency distribution of cervical cancer risk with DEDIKASI application

Referring to Table 3, it is evident that in the EWS Application group, the majority fall into the "Very Suspect" category, totaling 204 (52.6%), while in the DEDIKASI Application group, the majority are in the "High Risk" category, totaling 158 (40.7%).

Bivariate analysis

In Table 4, the research results reveal that the average value for the DEDIKASI application is 45.29, with a standard deviation of 16.370, a minimum value of 13, and a maximum value of 82. For the EWS application, the average is 59.17, with a standard deviation of 16.970, a minimum value of 6, and a maximum value of 89. The t-test results yield a p-value of 0.000, indicating a comparison of the effectiveness of the EWS Cervical Cancer Application with DEDIKASI on application users.

Table 5 presents research results showing that the average value for the DEDIKASI application is 75.81, with a standard deviation of 16.295, a minimum value of 33, and a maximum value of 100. For the EWS application, the average is 65.12, with a standard deviation of 16.139, a minimum value of 26, and a maximum value of 100. The t-test results yield a p-value of 0.000, indicating

a comparison of the EWS Cervical Cancer Application with DEDIKASI on application usage.

Discussion

Comparison of ISO assessment between EWS cervical cancer application and DEDIKASI

Testing this application aims to improve cervical cancer prevention, consequently enhancing the quality of life for women of reproductive age. Cervical cancer screening proves effective in reducing morbidity and mortality.¹⁹ Successful screening programs in communities not only raise awareness but also implement prevention and detection programs.²⁰

The high mortality rate in cervical cancer patients results from a lack of awareness, often identified only in advanced or late stages. A pivotal effort to reduce the number of cervical cancer cases involves early detection. Several studies propose methods or approaches for early detection, including the one conducted by Riani and Ambarwati (2020).²¹ This study provided exposure and discussions on early detection of cervical cancer, along with demonstrations of VIA and pap smear examinations to the community in Banyumas Regency, Central Java. Evaluation results indicated an increase in knowledge about cervical cancer symptoms and heightened awareness of VIA and pap smear examinations.

Subsequently, leveraging technological advancements, Agustyawati *et al.* (2021)²² proposed the design of an early cervical cancer detection application using Convolutional Neural Network (CNN) deep learning techniques. The study employed digital image data in the form of VIA results, categorized into two classes: positive cervix with 77 images and negative cervix with 82 images. The evaluation results demonstrated that the application design could detect cervical cancer with an accuracy of 96%.²³

Distribution of cervical cancer risk with the DEDIKASI application

Cervical cancer significantly impacts the quality of life for patients, their families, and healthcare financing by the government. Therefore, prevention and early detection efforts are crucial.²⁴ The low utilization of cervical cancer prevention services in low and middle-income countries is attributed to individual barriers, including a lack of knowledge and awareness about cervical cancer risk factors and prevention, age, marital status, socioeconomic status, religious and cultural beliefs, reproductive health-related stigma, and health system factors.²⁵ Cervical cancer is a malignancy that occurs in the cervix, the lower part of the uterus extending into the top of the vagina. Cervical cancer cells undergo changes over time, and signs of these changes may indicate the development of cancer.^{26,27}

Various government efforts to prevent and control cervical cancer include the Pap smear examination to raise public awareness. World Cancer Day is observed on February 4th. The Health Department's program includes activities in hospitals promoting and educating healthy and clean lifestyles while avoiding risk factors, administering HPV vaccination, and conducting screenings for early detection of cervical cancer.^{28,29} This screening aims to detect precancerous changes, which, if left untreated, can lead to cancer. Abnormalities found in the screening require follow-up with diagnosis and treatment to prevent cancer progression or treat it at an early stage.³⁰ The WHO recommends screening at least once for each woman in the target age group (30-49 years), with

recommended screening tests including HPV testing, cytology, and VIA.^{26,31,32}

This study's results align with some previous findings that indicate all informants perceive cervical cancer as a malignant disease, with its severity potentially leading to uterine loss and even death. Informants express a willingness to take preventive measures.^{33,34} In Nonik Ayu's research (2019),³⁵ women's beliefs were not related to early detection, possibly due to a lack of information about VIA and difficulties in scheduling time for health check-ups, including VIA tests, due to work or household responsibilities. Another study by Sahr and Kusumaningrum (2018)³⁶ states that women perceive cervical cancer as a disease with very serious consequences, with the belief that cervical cancer patients face a difficult and time-consuming treatment process with high associated costs. The perception of disease severity or symptoms felt is related to the willingness to undergo a VIA test. According to the Health Belief Model theory, individuals' actions in preventing or treating a disease are influenced by perceived benefits. Their actions depend on their evaluation of perceived vulnerability and perceived benefits, and they are more likely to adopt recommended health actions if they perceive them as beneficial.^{37,38}

The lack of early indications caused by cervical cancer results in women not realizing they have the disease until it is often too late for treatment, leading to many deaths among women.³⁹ Therefore, early detection of cervical cancer is necessary, as it can lead to a delay in the diagnosis and treatment of advanced-stage cervical cancer, which cannot yet be treated.⁴⁰ Additionally, reasons why women are reluctant to undergo examinations include psychological issues, lack of knowledge, and socioeconomic factors.⁴¹ The research concludes that the early detection of cervical cancer is influenced by the beliefs and knowledge of respondents after being educated through the application and directly explained by the researcher, making women more confident and willing to undergo early detection through the application.

Comparison of the effectiveness of the EWS cervical cancer application with DEDIKASI on user risk factors

Beyond relying on physical examinations, early detection of cervical cancer can be discerned by considering external factors like behavior and an individual's environment. Shalikhah *et al.* (2021)⁴² conducted a study examining the correlation between family support (environmental support) and attitudes toward early detection of cervical cancer. The research by Fransisca and Adhistry (2023),⁴³ emphasizes the crucial role of family support in managing and enhancing the motivation of cervical cancer patients. Alpan's study (2021)⁴⁴ delves into behavioral factors by utilizing behavioral data to identify the occurrence of cervical cancer in patients. The study employed eight classification algorithms and found that the Support Vector Machine (SVM) method, using the WEKA tool, achieved an accuracy rate of 91.67%. Additionally, a mother's knowledge of healthy living behaviors related to cervical cancer positively impacts early cervical cancer prevention behaviors.⁴⁵ Early detection is imperative to reduce the prevalence of cervical cancer cases and prevent advanced-stage conditions. Methods for early detection, including pap smears, the VIA test, pap smear, and colposcopy, contribute significantly to cervical cancer prevention.³⁰ Factors such as early sexual relationships, late marriage, and having multiple sexual partners also contribute to cervical cancer. Early detection represents an innovative breakthrough in healthcare development, aiming to reduce mortality and

morbidity associated with cervical cancer. Efforts to enhance the implementation of cervical cancer early detection include a focus on women's education.^{10,27}

Comparison of the EWS cervical cancer application with DEDIKASI in terms of application usage

The DEDIKASI application proves more effective when compared to the initial EWS Cervical Cancer application. Defined as "a system is a collection of components or variables whose contents consist of several interconnected, linked, and mutually supportive parts that unite as a whole (Unity) to achieve a specific goal effectively," an expert system serves as a computer application assisting in decision-making or problem-solving within a specific field. In contrast, an application is a computer program designed for users to perform specific tasks. Android, a touch-screen mobile device utilizing an operating system, employs Basic Android as a RAD (Rapid Application Development) tool for creating Android-based applications.

Earlier research focused on digital image processing solely to quantify the color characteristics of white lesions on the squamous columnar junction (SCJ) using zero-crossing edge detection and quantifying RGB values.⁴⁶ However, for accurate determination of VIA test results as positive or negative, understanding the color characteristics alone is insufficient. Crucial parameters in diagnosing cervical cancer, such as the shape and pattern of white lesions on the SCJ epithelial tissue, must be considered. Employing the Canny Edge Detection method, image processing was conducted, followed by data classification using Convolutional Neural Network to determine pre-cervical cancer diagnosis. The study yielded a 96% accuracy rate in detecting pre-cervical cancer.^{47,48}

Researchers assert that the DEDICATION application offers convenience through new features and consolidates all necessary health services into one accessible link. The application facilitates health workers in monitoring patients with a history of cervical cancer, providing consultation services via WhatsApp, and simplifying the delivery of education on management and risk factors for cervical cancer. The scope of this research is limited to women of childbearing age, aiming to detect early cervical cancer.

Conclusions

The study provides a thorough comparison of the effectiveness of the EWS Cervical Cancer Application and DEDICATION in terms of application usage, with DEDICATION proving more effective. Future research could delve deeper into user-specific factors influencing the application's efficacy, considering variables such as socio-economic backgrounds, education levels, and technological literacy. Additionally, exploring the long-term impact of consistent application use on cervical cancer prevention and detection outcomes could provide valuable insights. Furthermore, assessing the potential scalability of such applications in diverse cultural contexts would contribute to a more nuanced understanding of their global applicability.

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