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Submission Confirmation for Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia

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Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia

--Manuscript Draft--

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Abstract:	Objectives: This study is conducted to comprehensively document the process of developing and evaluating the usability of the tuberculosis screening application. Methods: The Design Science Research Methodology (DSRM) method is used to develop SIKRIBO app, which consists of six steps: problem identification and motivation, definition of objectives for a solution, design and development of products, demonstration, evaluation, and communication. A usability test was performed by using a System Usability Scale (SUS) questionnaire instrument to assess the application's usability. A total of 20 health volunteers and health workers participated in the usability tests as research participants. Results: The application was developed in two versions: web-based for administrators and android-based for users. The android-based has four main menus: find tuberculosis, tuberculosis education, latest info, and profiles. According to the usability test, the average SUS score is 76 (SD 8.00). Conclusions : This application has been developed to help detecting tuberculosis active cases in the community. The average SUS score shows that the apps is highly usable.

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Thank you for your consideration.

Yours Sincerely,

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Abstract

Objectives: This study is conducted to comprehensively document the process of developing and evaluating the usability of the tuberculosis screening application.

Methods: The Design Science Research Methodology (DSRM) method is used to develop SIKRIBO app, which consists of six steps: problem identification and motivation, definition of objectives for a solution, design and development of products, demonstration, evaluation, and communication. A usability test was performed by using a System Usability Scale (SUS) questionnaire instrument to assess the application's usability. A total of 20 health volunteers and health workers participated in the usability tests as research participants.

Results: The application was developed in two versions: web-based for administrators and android-based for users. The android-based has four main menus: find tuberculosis, tuberculosis education, latest info, and profiles. According to the usability test, the average SUS score is 76 (SD 8.00).

Conclusions: This application has been developed to help detecting tuberculosis active cases in the community. The average SUS score shows that the apps is highly usable.

Keywords: Tuberculosis, Health Information Systems, Mobile Application, mHealth, Usability Testing

I. Introduction

The World Health Organization (WHO) reports that, as of 2019, 10 million people were infected with tuberculosis with 1.2 million deaths [1]. Tuberculosis (TB) disease, if not treated properly, entails prolonged suffering for patients, resulting in increased transmission to family members and the community, and even death. The transmission rate of smear-positive tuberculosis patients is 65%. If one person with active TB can infect 10-15 people, the following year the number of those infected will reach 5.8 million [2].

India (26%), Indonesia (8.5%), and China (8.4%) are the three countries with the highest TB cases [3]. Unlike India and China, Indonesia has been not only a country with high cases, but low case detection and reporting has made Indonesia the largest contributor to the reporting gap of TB cases in the world by 10% [3]. As highlighted in the national TB strategy, active case-finding is the primary focus of TB control. The low TB cases found in the community will potentially increase the community's rate of transmission [4].

Rahayu et al. found that one of the factors in the incidence of TB cases is poor knowledge about the TB symptoms and prevention which contributed to delayed diagnosis [5]. This finding is supported by a longitudinal study which estimated only 52.5% of patients who began treatment were aware that cough was a symptom of TB, while the rest knew little about it [6]. Those with undiagnosed TB act as reservoirs for transmission to their families.

The Case Notification Rate (CNR) is one indicator that describes the scope of TB case-finding. The Central Java tuberculosis CNR has dropped from 157 per 100,000 people in 2019 to 111 per 100,000 people in 2020 [7]. According to Semarang Health Office report in 2021, the tuberculosis case notification rate in Semarang (the capital city of Central Java province) decreased from 258 per 100,000 population in 2019 to 155 per 100,000 population in 2020 [8]. Based on the 2018 Semarang Health Office report, the number of TB case-finding in Semarang in 2019 was 1,653 cases [9].

The Sekaran Public Health Center (PHC) as a health service center at village level plays a role in finding TB cases in Gunungpati, one district in Semarang. According to a preliminary research, TB cases remain active in the Sekaran Health Center's working area, with 329 suspected cases in 2021 [8]. However prevalent, community-based active case-finding has not been carried out actively. Establishing health Volunteers is one of the efforts of the Sekaran PHC to empower the community in finding TB cases. Volunteers selected from the community are expected to play a central role in improving family health and performing early detection of TB symptoms in their family members to receive a prompt and adequate treatment.

During the COVID-19 pandemic, the tuberculosis program faced numerous challenges, particularly in the case-finding program. This is due to the need to avoid direct contact during the pandemic, especially those with cough symptoms [10]. This direct physical contact can actually be replaced by virtual contact to diminish the risk of exposure. Mobile health (mHealth) applications offer a way to overcome the challenges in TB case-finding [11].

mHealth is the application of technology in the medical world and public health through mobile devices such as mobile phones, tablet computers, personal digital assistants, and relevant devices. mHealth technologies include voice and short message services, mobile phone applications, remote monitoring, and portable sensor devices. This technology can also be equipped with geographic information system and global positioning system, which are used for geographic mapping [12].

The use of mHealth has been recognized as an affordable health system innovation that makes high-quality health services accessible to patients in low- and middle-income countries. This includes Indonesia given its poor health systems, high prevalence of tropical and infectious diseases, and high mortality rates [13]. However, in terms of digital penetration, the use of mobile phones in Indonesia ranks fourth in the world with 61.7% of the population

has access to mobile gadgets (14).

Based on Keutzer et al. (2020), there are at least 55 mHealth applications available related to TB treatment [15]. Out of this figure, only 6% of mHealth applications focus on TB screening which is under-researched in scholarly publications [15,16]. Several mHealth applications related to TB screening, such as Tuberspot, TimBre, and SiTubo. Tuberspot is an apps made in Spain which informs users about shapes, colors, groups, and how to distinguish TB bacilli based on their artifacts [15]. TimBre is Indian-based TB apps which focused on cough screening for pulmonary tuberculosis detection [17], whereas Si Tubo is made in Indonesia which focuses on early detection of tuberculosis symptoms in children. Therefore, the objective of this research is to comprehensively document the process of developing and determining the usability of the tuberculosis screening application.

II. Methods

The development of The Tuberculosis Screening System Application (SIKRIBO app) employed Design Science Research Methodology (DSRM) which consist of six activities. The detailed steps are presented in Figure 1.

1. Activity 1: Identifying problems and motivation

Preliminary field studies were conducted to identify the challenges associated with finding TB cases.

2. Activity 2: Defining objectives of a solution

At this stage, the objectives of getting a solution from the problem previously identified are determined. This activity is considered a “thought experiment” to explore the feasibility of each approach. The literature reviews were conducted to build on prior research, map the issues and find a solution. There was also a review of studies that evaluated and tested various TB apps. The purpose of this study is to comprehensively document the process of

developing and test the usability of android-based application products that focus on finding TB active cases.

3. Activity 3: Product design and development

SIKRIBO app designed to be user-friendly with the objective of early TB screening in finding suspected cases of TB in the community. It has two platforms: a web-based admin and an Android-based client. The web version is used to manage application data and configuration, whereas the android version collects screening data. This application was developed by Tugutech Software Development Studio and created on the Android platform in *Bahasa Indonesia*, Indonesian national language where mostly everyone can access. The database required for the application can be seen in figure 2.

4. Activity 4: Demonstrations

This activity includes a simulation of running the application prototype. The demonstration is carried out in stages:

1) Internal trial

By analyzing the internal workings and structure of a software, white box testing can uncover system implementation errors such as poor key management. The path coverage technique was used to test application in order to see the cyclometic complexity in the system.

2) Expert validity

Expert validity was carried out through a trial of application products by media experts and Public Health experts. A questionnaire in the form of a validation sheet was distributed to assess, validate, and evaluate the application.

3) Black-box test

Black Box Testing is testing on software that is carried out without knowledge or observation of internal work and only observing the fundamental aspects of the system. Black Box Testing is a test case design strategy used to ensure that any specified system function or

input is fully operational. The black box testing stage is a trial stage conducted by health officers of Sekaran PHC acting as administrators and users. The Black-Box test results show that the application runs optimally and can be used accordingly and reliably.

5. Activity 5: Evaluation (Usability Test)

The mobile application is evaluated using a usability test. The purpose of this test is to determine the extent to which users can use a product to achieve specific goals by taking into account the effectiveness, efficiency, and satisfaction of using a product. A usability test determines how well a system, product, or service can be used by specific users to achieve goals with effectiveness, efficiency, and satisfaction in the context of use [19].

1) Research Population and Design

This study uses a cross sectional design to determine the usability of SIKRIBO app. The sample population in this study were health cadres and health workers at Sekaran PHC, Semarang whose age ranges from 17-65 years. They have used SIKRIBO app and were willing to participate in this study.

2) Determination of Sample Size

In order to determine the usability test, a total of 20 respondents were chosen as representatives. The number of samples is chosen based on the findings of quantitative research of usability tests [20]. The sampling technique used in this study is purposive sampling.

3) Research Instrument

This study uses a questionnaire instrument from System Usability Scale (SUS) which has been adapted into Indonesian language and context. This SUS consists of 10 statement items with odd number patterns for positive statements and even numbers for negative statements. The SUS measures the usefulness of a product which is based on a likert scale from 1 (strongly disagree) to 5 (strongly agree). More specifically, the points are classified as

positive responses if they choose a score of 5 or 4 for odd items (positive statements) and scores and scores of 1 or 2 for even items (negative statements); neutral if they choose a score of 3; and negative if the beta tester chooses a score of 1 or 2 for odd items and a score of 5 or 4 for even items [21].

For positive statement of SUS scores, the score contribution is scale position minus 1 and for negative statements, the score contribution is 5 minus scale position. The overall SUS score is the result of adding up the contribution of the item scores multiplied by 2.5, ranging from 0 to 100. A product is considered to have good usability and high acceptance if the overall SUS score is equal to or above 68 [19].

4) Data Collection

The data was collected by asking research participants to complete a questionnaire. It is done online by using Google Form. This questionnaire was distributed to respondents in a whatsapp group of research participants consisting of health volunteers, health workers and researchers.

5) Data Analysis

Data were statistically analyzed by using data analysis software. Data is presented in terms of frequency and percentage for categorical data, and mean and standard deviation of the mean (SD) for numerical data.

6) Ethical Statement

This research has obtained permission from the Health Research Ethics Commission of the Public Health Department, Universitas Negeri Semarang number 096/KEPK/EC/2021.

III. Result

1. Product Design and Development

The tuberculosis screening application is divided into two versions:

1) Client Based on Android

The Android version is used to collect patient screening data. It has four main menus demonstrated in figure 3:

(1) Find TB

It is an early tuberculosis screening form that cadres must fill out when screening TB in the community. It includes a personal data form for the person being screened as well as a questionnaire form consisting of ten questions for TB screening.

(2) TB Education

The menu contains TB-related information. This menu is expected to provide the community with insight and knowledge about TB disease.

(3) Latest Info

This menu displays various kinds of the latest information about TB disease. The information was obtained from various trusted sources which are expected to provide updated information about tuberculosis and prevent the spread of hoax on TB in the community.

(4) Profile

When a user logs in with a Google account, the Profile menu will automatically display user data in the form of name and email address. This profile update is expected to provide information to Primary Health Care regarding the personal data of the data input (user), with the goal of maintaining communication in the future regarding the ongoing TB screening follow-up.

2) Web-Based Admin

The web version is accessible to health worker users, as well as the research team and application developers who need to monitor and manage the screening performed by users (Figure 4).

2. Evaluation (Usability Testing)

1) Socio-Demographic Characteristic

The initial version of the TB screening application has been produced and usability tests have been carried out to evaluate the usefulness of the application at the user (agent) level. Usability testing was carried out on 20 participants with the demographic characteristics presented in Table 1. The majority of participants are in the age group of 17-25 years (40%). Most of the respondents have the last education at the tertiary level with a percentage of 70% and 90% of respondents are female.

2) Usability Testing

Usability testing is used to discover and troubleshoot any errors made by users when using mobile-based applications. Based on table 2, almost all statements have a higher proportion of positive responses. Statements number 1 and 7 have the highest percentage of positive responses (95%). For Statement number 10 has the highest percentage of negative responses, it is 50%. The highest average score is in the 3rd statement regarding the user-friendliness of the application with a score of 3.4 (SD 0.68) and the lowest average score is 1.7 (SD 1.22) in statement no 10 related to self-adjustment before use the app. The SUS score is 76, which is higher than the system's minimum usability score (68). These results indicate that the application has a high acceptability and good usability.

IV. Discussion

The TB screening application, which is based on Android, is intended to assist in the detection of TB cases in the community. According to the results of the usability test, 95% of respondents think they will use it again and believe that other users will quickly understand how to use the application. The percentage of users who intend to use this application again in the future is a good sign, because user retention is a challenge in the development and

implementation of mHealth [22].

To ensure the long-term viability of mHealth, updates or changes that adapt to the changing circumstances of its users are need by considering personal health needs, available resources and structures, environmental characteristics, economic changes, and social acceptance [23]. Users' willingness to use and accept the mobile-based mHealth is positively related to their perception of the application's ease of use and usefulness [24]. In order to achieve this perception, mHealth service providers can improve the application's ease of use and create technology that is user friendly [25].

Furthermore, 50% of respondents said that users should learn and familiarize themselves with the application before using it. These findings are consistent with the findings of Pande et al. (2017), who discovered that as many as 50% of respondents gave a negative response to the statement "I need to learn a lot of things before I could get started with the application." This is understandable given that new technology necessitates user adaptation [26]. One of the challenges in implementing mHealth is taking the time to study the app before deploying it. Experts must explain the benefits of using the application to users before they are willing to adopt it into their clinical practice [27].

The SUS score is 76 (SD 8.00), which means that this application has good usability. Idrus et al. (2020) shared similar finding where the average SUS score on web-based HIV and tuberculosis therapy management applications was 77.7 [28]. Another study found that the average SUS score on mHealth was 80.5 (SD 11.47), indicating that the application has good usability [29]. The higher the SUS score, the better a system/usability application [30].

The challenge in implementing this application is that users must adapt and learn before they can use it, like any other apps. Health cadres can provide education and training on how to use the application to address this issue.

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Table 1. Socio-Demographic Characteristics (n = 20)

Variables	Frequency
	n (%)
Age (years)	
17-25	8 (40.0)
26-35	5 (25.0)
36-45	4 (20.0)
46-55	2 (10.0)
56-65	1 (5.0)
Education Level	
Elementary School	1 (5.0)
Junior High School	1 (5.0)
Senior High School	4 (20.0)
College	14 (70.0)
Gender	
Male	2 (10.0)
Female	18 (90.0)

Table 2. Usability Testing (n = 20)

Statement	Responses			Mean Score (SD)
	Positive	Neutral	Negative	
	n (%)	n (%)	n (%)	
I think that I would like to use this application	19 (95.0)	1 (5.0)	-	3.3 ± 0.6
I found application unnecessarily complex	17 (85.0)	3 (15.0)	-	3.1 ± 0.6
I thought application was easy to use	18 (90.0)	2 (10.0)	-	3.4 ± 0.7
I think that I would need the support of a technical person to be able to use application	15 (75.0)	3 (15.0)	2 (10.0)	4.0 ± 1.1
I found the various functions in application were well integrated	18 (90.0)	2 (10.0)	-	3.2 ± 0.6
I thought there was too much inconsistency in application	16 (80)	2 (10.0)	2 (10.0)	3.0 ± 0.9
I would imagine that most people would learn to use application very quickly	19 (95.0)	1 (5.0)	-	3.4 ± 0.6
I found application very cumbersome to use	16 (80.0)	3 (15.0)	1 (5.0)	3.1 ± 1.0
I felt very confident using application	18 (90)	2 (10)	-	3.4 ± 0.7
I needed to learn a lot of things before I could get going with application	5 (25.0)	5 (25.0)	10 (50.0)	1.7 ± 1.2
Total Responses	161 (80.5)	24 (12.0)	15 (7.5)	
SUS[a] Score				76 (8.0)

a. System Usability Scale (SUS)

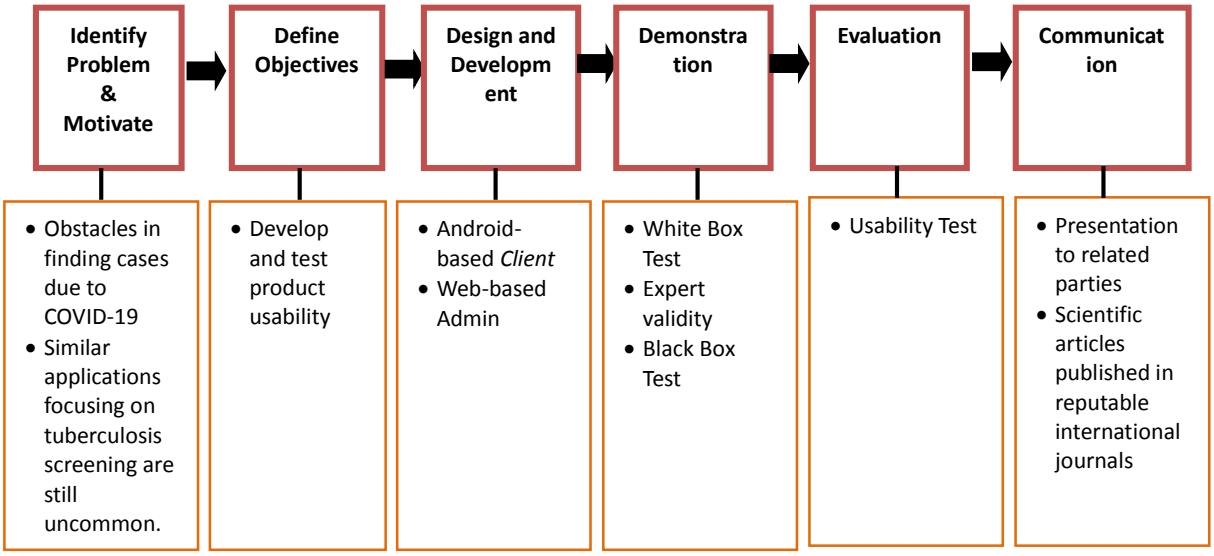

Figure 1. DSRM Process Model on Tuberculosis Screening Application

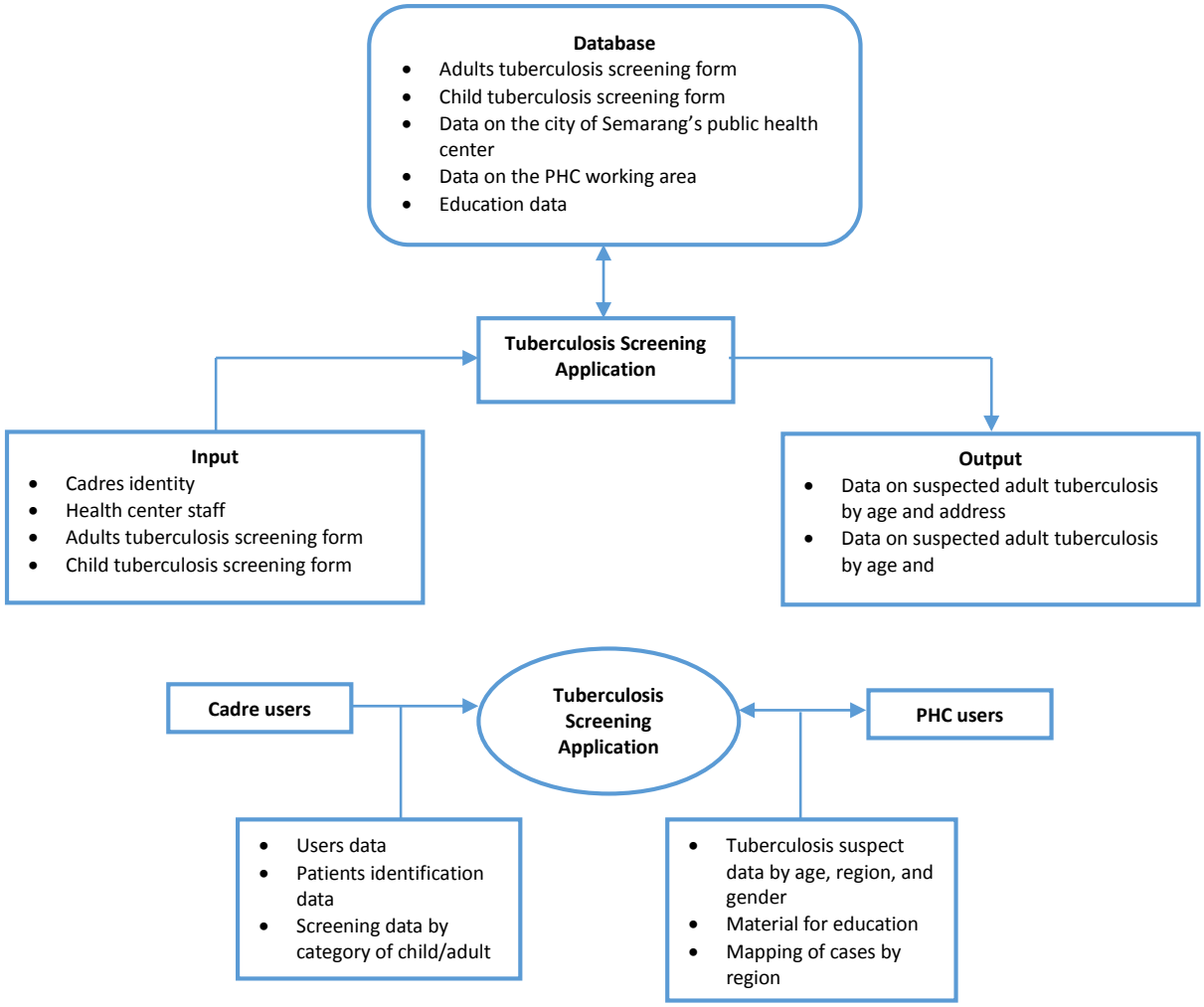

Figure 2. Database on the Tuberculosis Screening Application

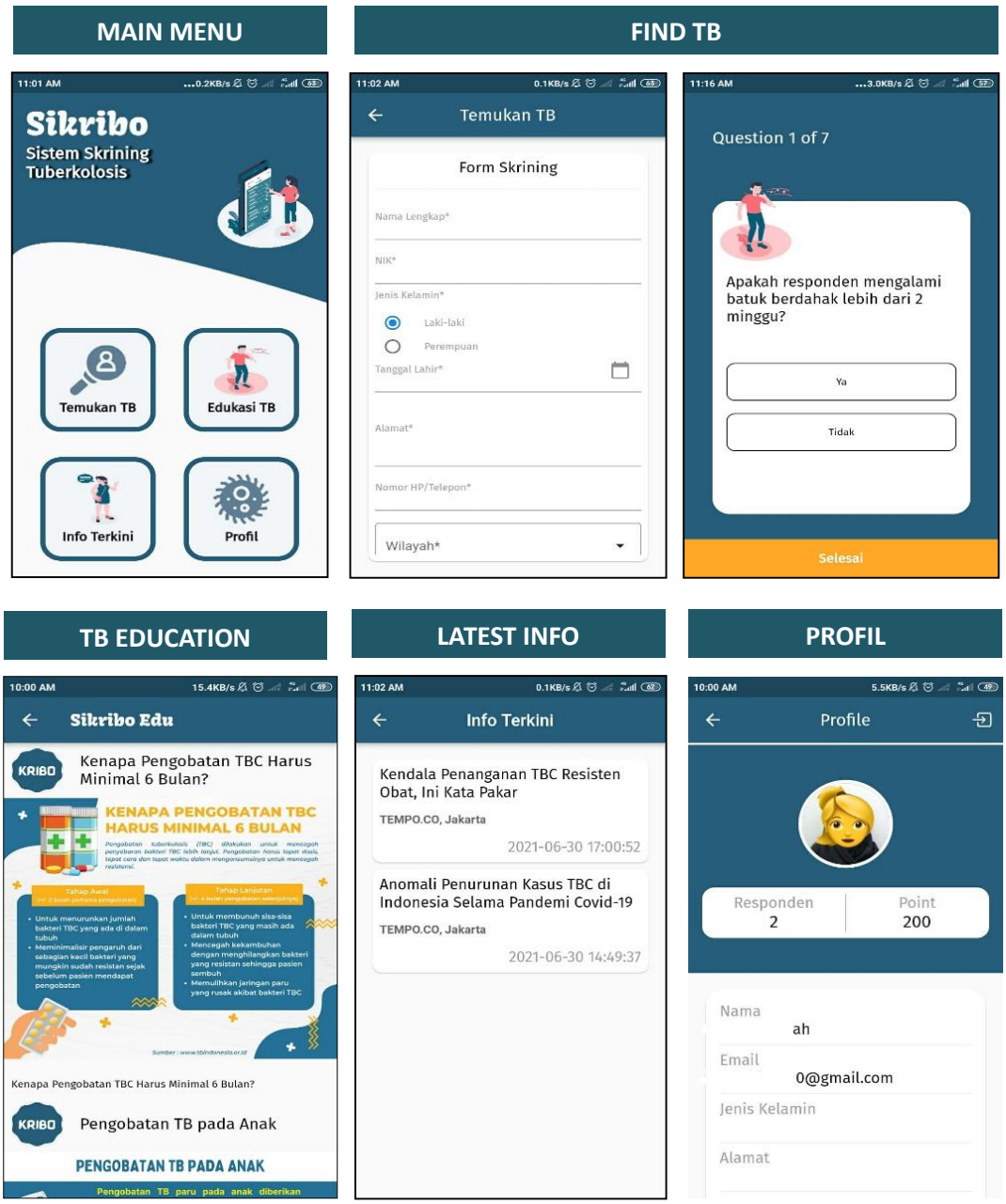

Figure 3. Display Menus Client Based on Android: 1) Main menu; 2) Find TB; 3) TB education; 4) Latest Info; 5) Profile.

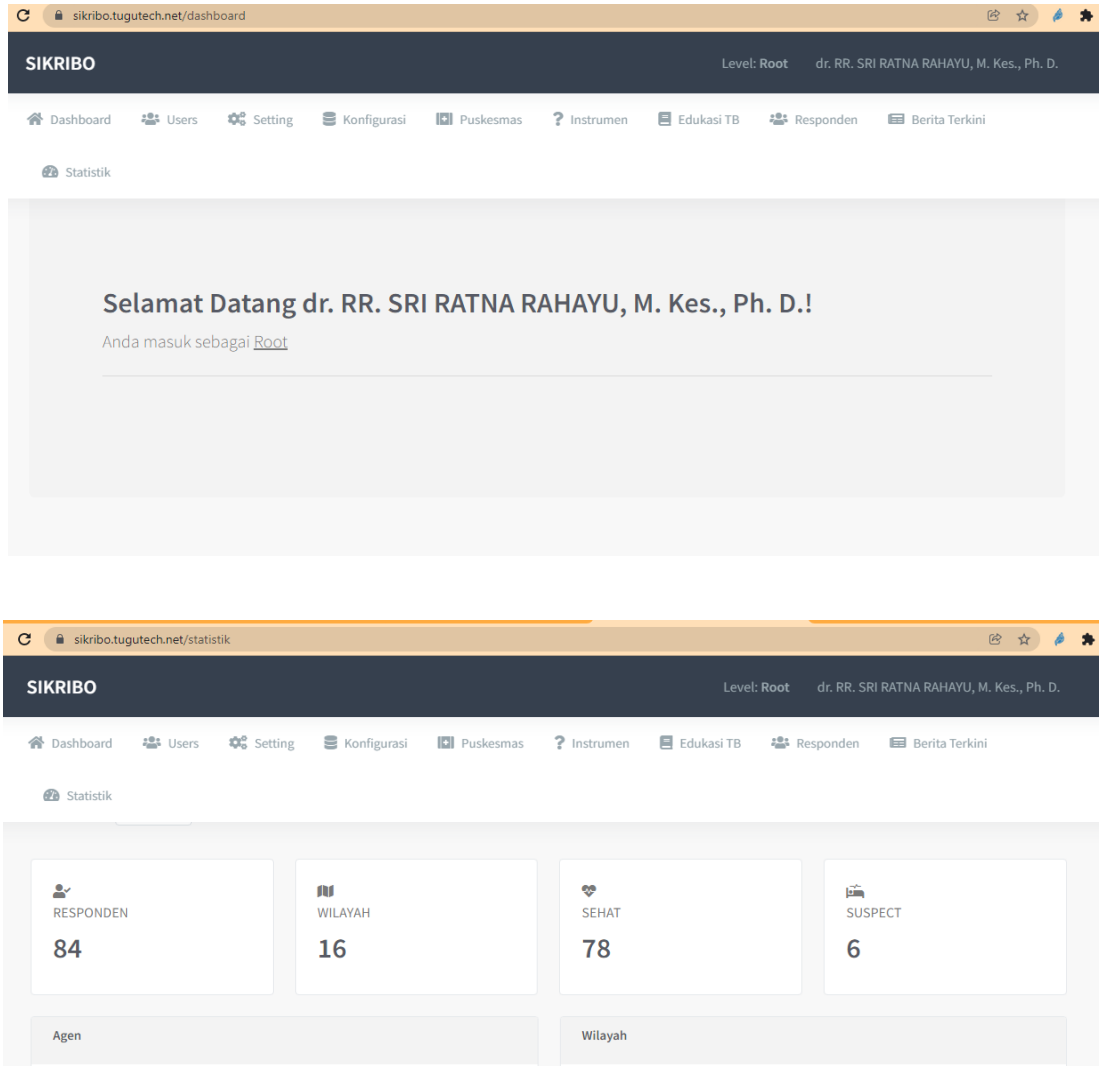

Figure 4. Web-Based Admin Display

2. Bukti konfirmasi review dari Editor (29 April 2022)

UNNES
UNIVERSITAS NEGERI SEMARANG

RR. SRI RATNA RAHAYU <sriratnarahayu@mail.unnes.ac.id>

Your submission entitled Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia

2 messages

Healthcare Informatics Research <em@editorialmanager.com> Fri, Apr 29, 2022 at 11:57 AM
Reply-To: Healthcare Informatics Research <hir@kosmi.org>
To: Sri Ratna Rahayu <sriratnarahayu@mail.unnes.ac.id>

Dear Mrs. Rahayu,

Your submission entitled "Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia" has been received by the journal, however, it is being returned to you for the following reason(s):

We reviewed your manuscript according to the HIR manuscript guideline.

* Abstract is written with 200~250 words.
* Five keywords should be listed, and they should be selected from the Medical Subject Heading (MeSH) in Medline, published by the US National Library of Medicine (https://meshb.nlm.nih.gov/search).
* Please change the Indonesian language in the figures to English.

Please address the above issue(s) prior to resubmitting your manuscript.
Thank you for submitting your work to this journal.

Kind regards,
Editorial office
Healthcare Informatics Research

RR. SRI RATNA RAHAYU <sriratnarahayu@mail.unnes.ac.id> Wed, May 4, 2022 at 6:59 PM
To: fiena Merzistya <finamerzistya@gmail.com>

Sent from my iPhone

Begin forwarded message:

From: Healthcare Informatics Research <em@editorialmanager.com>
Date: 29 April 2022 11.58.41 GMT+7
To: Sri Ratna Rahayu <sriratnarahayu@mail.unnes.ac.id>
Subject: Your submission entitled Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia
Reply-To: Healthcare Informatics Research <hir@kosmi.org>

[Quoted text hidden]

3. Bukti konfirmasi submit revisi pertama (10 Mei 2022)

UNNES
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RR. SRI RATNA RAHAYU <sriratnarahayu@mail.unnes.ac.id>

Your PDF Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia has been built and requires approval

2 messages

Healthcare Informatics Research <em@editorialmanager.com> Tue, May 10, 2022 at 9:45 PM
Reply-To: Healthcare Informatics Research <hir@kosmi.org>
To: Sri Ratna Rahayu <sriratnarahayu@mail.unnes.ac.id>

Dear Mrs. Rahayu,

The PDF for your submission, "Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia" is ready for viewing.

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Please view the submission before approving it to be certain that your submission remains free of any errors.

Thank you for your time and patience.

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Healthcare Informatics Research
https://www.editorialmanager.com/hir/

In compliance with data protection regulations, you may request that we remove your personal registration details at any time. (Use the following URL: https://www.editorialmanager.com/hir/login.asp?a=r). Please contact the publication office if you have any questions.

Healthcare Informatics Research <em@editorialmanager.com> Tue, May 10, 2022 at 10:01 PM
Reply-To: Healthcare Informatics Research <hir@kosmi.org>
To: Sri Ratna Rahayu <sriratnarahayu@mail.unnes.ac.id>

Dear Mrs. Rahayu,

The PDF for your submission, "Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia" is ready for viewing.

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4. Bukti konfirmasi terbit ID paper (HIR-22-041)

(12 Mei 2022)

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RR. SRI RATNA RAHAYU <sriratnarahayu@mail.unnes.ac.id>

A manuscript number has been assigned to Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia

1 message

Healthcare Informatics Research <em@editorialmanager.com> Thu, May 12, 2022 at 9:47 AM
Reply-To: Healthcare Informatics Research <hir@kosmi.org>
To: Sri Ratna Rahayu <sriratnarahayu@mail.unnes.ac.id>

CC: "Intan Zainafree" intanzainafree@gmail.com, "Widya Hary Cahyati" widyahary27@mail.unnes.ac.id, "Eko Farida" e_farida@mail.unnes.ac.id, "Aufiena Nur Ayu Merzistya" finamerzistya@gmail.com, "Anggun Dessita Wandastuti" anggundessita@gmail.com, "Isbandi Isbandi" is_bandi@yahoo.com, "Nur Wahidah" nwahidah10@gmail.com, "Muhamad Zakki Saefurrohim" saefurrohim@students.unnes.ac.id, "Muhamad Anbiya Nur Islam" mail.anbiya@gmail.com, "Alvy Fajri" alvyfajri@gmail.com, "Mona Subagja" mona@mail.unnes.ac.id

Dear Mrs. Rahayu,

Your submission entitled "Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia" has been been assigned the following manuscript number: HIR-22-041.

Thank you for submitting your work to this journal.

Kind regards,

Editorial office
Healthcare Informatics Research

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5. Bukti konfirmasi review dan hasil review pertama (22 Juni 2022)

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RR. SRI RATNA RAHAYU <sriratnarahayu@mail.unnes.ac.id>

Your Submission

1 message

Healthcare Informatics Research <em@editorialmanager.com> Wed, Jun 22, 2022 at 5:21 PM
Reply-To: Healthcare Informatics Research <hir@kosmi.org>
To: Sri Ratna Rahayu <sriratnarahayu@mail.unnes.ac.id>

Ref.: Ms. No. HIR-22-041
Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia
Healthcare Informatics Research

Dear Mrs. Rahayu,

Reviewers have now commented on your paper. You will see that they are advising that you revise your manuscript. If you are prepared to undertake the work required, I would be pleased to reconsider my decision.

For your guidance, reviewers' comments are appended below.

If you decide to revise the work, please submit a list of changes or a rebuttal against each point which is being raised when you submit the revised manuscript.

Your revision is due by Jul 06, 2022.

To submit a revision, go to https://www.editorialmanager.com/hir/ and log in as an Author. You will see a menu item call 'Submission Needing Revision'. You will find your submission record there.
You can download the manuscript files from 'File Inventory' and you should revise your submission using these files.

Yours sincerely,

Hyejung Chang, Ph.D.
Editor-in-Chief
Healthcare Informatics Research

Comments from the Editors and Reviewers:

Editor: Reviewer #1: The autohs present this study "Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia" very important to design mhealth App. The subject addressed in this article is worthy of investigation because document the process of developing and evaluating the usability of the tuberculosis screening application.

The authors should review and explain:
1. Why select the Design Science Research Methodology (DSRM) method
2. Why select System Usability Scale (SUS) questionnaire instrument
3. Why not used IOS version
4. What was missing to reach 8.0/8.0 of SUS. Next studies?

The authors should be review this information:
References not current:
#2 from 2014
#19 from 2006
#29 from 2013

Line 22-32 [11]. Don´t apply for this study
Line 56: 6) Ethical Statement don´t have data of University (XXX)

Reviewer #3: Comments to author,

Thank you very much for submitting a paper on a good subject.
Unfortunately, I thought that it would be difficult to publish the status. I give feedback to the author on a few points.

Best regards,

1. Additionally, it will be easier to understand if you draw a SUS score chart.

2. The SUS scale generally uses a 5-point scale, but is there a reason to use a 3-point scale?
It would be good to present similar prior research or simillar study.

3. How were the people who took the test selected?
And since the people who participated in the evaluation differ between occupational groups, these factors may act as a bias.

4. In order to increase the credibility of the survey results, I think that the kappa value among respondents is necessary.

5. I recommend that you specify your data processing software (e.g, SPSS, SAS, excel etc. on.)

6. If the results on user satisfaction after future use are specified, I think that it will be a study of more academic value.

7. The intent of this thesis is ambiguous. In order to have more value, I think it is necessary to explain what the prediction rate or diagnosis rate of the gold standard is, even though the apps were developed with certain parameters.

Best regards,
Choi Wook jin, KOREA

Reviewer #4: Thank you for giving me the opportunity to review this paper entitled "Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia". The topic is important especially in Indonesia, but from my perspective there are some concerns for this study. How to use the application is not well presented. For example, provide specific details on how to perform a tuberculosis screening test using the application and how it will help the TB cases' self-care. It also requires more detailed description of the content development process of the application. And in the discussion section, what significance this application has and how it will benefit public health should be described.

_____

Revision_Due.ics
1K

Date: Jun 22, 2022
To: "Sri Ratna Rahayu" sriratnarahayu@mail.unnes.ac.id
From: "Healthcare Informatics Research" hir@kosmi.org
Subject: Your Submission
Attachment(s): Revision_Due.ics

Ref.: Ms. No. HIR-22-041
Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia
Healthcare Informatics Research

Dear Mrs. Rahayu,

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Editor-in-Chief
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****

6. Bukti konfirmasi permintaan perpanjangan waktu revisi ke Editor (5 Juli 2022)

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RR. SRI RATNA RAHAYU <sriratnarahayu@mail.unnes.ac.id>

Request for extension of revision deadline

2 messages

RR. SRI RATNA RAHAYU <sriratnarahayu@mail.unnes.ac.id> Tue, Jul 5, 2022 at 10:55 AM
To: hir@kosmi.org
Cc: em@editorialmanager.com

Hyejung Chang, Ph.D.
Editor-in-Chief
Healthcare Informatics Research

Dear Hyejung Chang, Ph.D.,
I am Sri Ratna Rahayu, author of the article “Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia" (No. HIR-22-041) that was submitted at Healthcare Informatics Research Journal.

I apologize for not being able to submit the revised article by the deadline (July 6th, 2022). Currently, my team and I are still discussing to revise the article given by the reviewers. Therefore, I request to be given additional time for submitting revisions.
I will submit revisions as soon as possible or in accordance with the deadline that will be given again by the Healthcare Informatics Research Journal.

I apologize for this inconvenience. I hope you will consider it and I will appreciate all your decisions. Thank you for your understanding.

Your sincerely,
Sri Ratna Rahayu, (dr., M.Kes., Ph.D)

Head of Public Health Postgraduate Program
SEMARANG STATE UNIVERSITY (UNNES)
A Building, Post Graduate Campus Jl. Kelud Utara III 50237
Semarang, Indonesia
Phone : +62 (0) 24 844 0516
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Fax : +62 (0) 24 844 0516
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Cc: em@editorialmanager.com
Bcc:
Date: Tue, 5 Jul 2022 10:55:06 +0700
Subject: Request for extension of revision deadline
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7. Bukti konfirmasi submit revisi pertama, revisi telah diterima, dan artikel yang diresubmit (12 Juli 2022)

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RR. SRI RATNA RAHAYU <sriratnarahayu@mail.unnes.ac.id>

Your PDF Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia has been built and requires approval

1 message

Healthcare Informatics Research <em@editorialmanager.com> Tue, Jul 12, 2022 at 2:06 PM
Reply-To: Healthcare Informatics Research <hir@kosmi.org>
To: Sri Ratna Rahayu <sriratnarahayu@mail.unnes.ac.id>

Dear Mrs. Rahayu,

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Submission Confirmation for HIR-22-041R1

1 message

Healthcare Informatics Research <em@editorialmanager.com> Tue, Jul 12, 2022 at 2:08 PM
Reply-To: Healthcare Informatics Research <hir@kosmi.org>
To: Sri Ratna Rahayu <sriratnarahayu@mail.unnes.ac.id>

Ref.: Ms. No. HIR-22-041R1
Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia

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Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia

--Manuscript Draft--

Manuscript Number:	HIR-22-041R1
Full Title:	Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia
Short Title:	SIKRIBO Mobile App for Tuberculosis
Article Type:	Original Article
Section/Category:	Application systems
Keywords:	Mobile Applications; Research Design; Community Participation; Tuberculosis; Internet
Corresponding Author:	Sri Ratna Rahayu, Ph.D. Universitas Negeri Semarang Semarang, INDONESIA
Corresponding Author's Institution:	Universitas Negeri Semarang
Corresponding Author's Secondary Institution:	
First Author:	Sri Ratna Rahayu, Ph.D.
First Author Secondary Information:	
Order of Authors:	Sri Ratna Rahayu, Ph.D.
	Intan Zainafree, Dr.
	Widya Hary Cahyati, Dr.
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	Isbandi Isbandi, S.T.
	Nur Wahidah, S.K.M
	Muhamad Zakki Saefurrohim, S.K.M.
	Muhamad Anbiya Nur Islam, S.Kom
	Alvy Fajri, S.Kom
	Mona Subagja, S.Pd.
Abstract:	Objectives: This study is conducted to comprehensively document the process of developing and evaluating the usability of the tuberculosis screening application. Methods: The Design Science Research Methodology (DSRM) method is used to develop SIKRIBO app, which consists of six steps: problem identification and motivation, definition of objectives for a solution, design and development of products, demonstration, evaluation, and communication. A usability test was performed by using a System Usability Scale (SUS) questionnaire instrument to assess the application's usability. A total of 20 health cadres and health workers participated in the usability tests as research participants. Results: The application was developed in two versions: android-based for users and web-based for administrators. The android-based has four main menus: Find Tuberculosis, Tuberculosis Education, Latest Info, and Profile. The web version is accessible to health worker users, as well as the research team and application developers who need to monitor and manage the screening performed by users. According to the usability test, the average SUS score is 76 (SD 8.00).

	Conclusions : This application has been developed to help detecting tuberculosis active cases in the community. The average SUS score shows that the apps is highly usable. So, this application is expected to be implemented in all health facilities to increase the TB case finding rate with active community participation.
Additional Information:	
Question	**Response**
Order of Authors (with Contributor Roles):	Sri Ratna Rahayu, Ph.D. (Conceptualization; Data curation; Methodology; Writing – review & editing)
	Intan Zainafree, Dr. (Conceptualization; Formal analysis; Methodology)
	Widya Hary Cahyati, Dr. (Data curation; Methodology)
	Eko Farida, Dr. (Conceptualization)
	Aufiena Nur Ayu Merzistya, M.K.M. (Conceptualization; Methodology; Writing – original draft; Writing – review & editing)
	Anggun Dessita Wandastuti, S.K.M. (Project administration)
	Isbandi Isbandi, S.T. (Conceptualization)
	Nur Wahidah, S.K.M (Data curation; Writing – original draft; Writing – review & editing)
	Muhamad Zakki Saefurrohim, S.K.M. (Data curation; Formal analysis; Writing – review & editing)
	Muhamad Anbiya Nur Islam, S.Kom (Software)
	Alvy Fajri, S.Kom (Software)
	Mona Subagja, S.Pd. (Validation)
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Manuscript Classifications:	1: Application systems; 1.03: Primary care and public healthcare information system

Comments from the Editors and Reviewers and the Revision from the Authors

Reviewer	No	Comments	Revisions
Reviewer #1			
	1	Why select the Design Science Research Methodology (DSRM) method	The Design Science Research Methodology (DSRM) method was chosen because it is more practical and concentrates on developing, implementing, and evaluating the designed artifact with the specific goal of enhancing its functional performance
	2	Why select System Usability Scale (SUS) questionnaire instrument	The SUS was chosen as the instrument because it has been well validated as a measure of the mobile applications usability in questionnaire-based studies and has proven to be very valid in various previous studies. SUS in this study which has been adapted into Indonesian language, validated, and reliability (Cronbach Apha: 0.841).
	3	Why not used IOS version	Android was chosen because it covers almost all of the market share mobile application in Indonesia, it has 90.84% market share of Indonesian mobile phone users
	4	What was missing to reach 8.0/8.0 of SUS. Next studies?	8.0 is the value of Standard Deviation (SD) of SUS.
	5	References not current: #2 from 2014 #19 from 2006 #29 from 2013	We have removed and changed the references with more recent references
	6	Line 22-32 [11]. Don´t apply for this study	We have changed the sentence to “Mobile health (mHealth) applications as a solution in the transformation of health technology to overcome the challenges in TB case-finding”

	7	Line 56: 6) Ethical Statement don´t have data of University (XXX)	This research was approved by Health Research Ethics Commission, Department of Public Health, Semarang State University (No.096/KEPK/EC/2021) and all participants required to sign an informed consent.
Reviewer #3			
	1	Additionally, it will be easier to understand if you draw a SUS score chart.	We have added and attached the SUS score chart on the figure file
	2	The SUS scale generally uses a 5-point scale, but is there a reason to use a 3-point scale? It would be good to present similar prior research or simillar study	The 3-point scale is carried out to overcome the occurrence of habitual bias in respondents who are involved in measuring the usability of this application. We cited similar prior research, Muhamat et. al's (2021) research that developed the Gigiku Sihat application and tested the usability of the application.
	3	How were the people who took the test selected? And since the people who participated in the evaluation differ between occupational groups, these factors may act as a bias.	A total of 20 respondents were chosen as representatives of usability trials. The number of samples is chosen based on the findings of Nielsen (2004). This sample selection was done by convenience sampling technique, which is the most frequently used method in usability studies. The sample is health cadres and PHC workers aged 17-65 years who are the target users of SIKRIBO in the future, to carry out TB screening for the general public. Sampling was carried out at the Sekaran PHC in Semarang as a pilot health center.
	4	In order to increase the credibility of the survey results, I think that the **kappa value** among respondents is necessary.	We have added the kappa value among respondents with the results is with the results of a high enough kappa value, or moderate agreement (Kappa: 0.494).
	5	I recommend that you specify your data processing software (e.g, SPSS, SAS, excel etc. on.)	The data of SUS were calculated by using Microsoft® Excel® and analyzed by using data analysis

			software, IBM® SPSS® Statistics Version 26
	6	If the results on user satisfaction after future use are specified, I think that it will be a study of more academic value.	In the discussion, we have explained about the user satisfaction of SIKRIBO after future use. Based on the results, most of the respondents think they will use it again. This respondent's desire is because of the ease of use of this application. The high number of users who intend to use this application again in the future is a good sign, because user retention is a challenge in the development and implementation of mHealth. An easy-to-use mobile application will be related to the user's intention to use it again
	7	The intent of this thesis is ambiguous. In order to have more value, I think it is necessary to explain what the prediction rate or diagnosis rate of the gold standard is, even though the apps were developed with certain parameters.	This study develops a TB screening application to capture people suspected of being infected with TB. This application screens only through the physical symptoms of TB felt by the respondent in the last 1 month. This screening is not for diagnosing respondents infected with TB, but there is a need for follow-up by the nearest primary health care, which is the admin of this application, to carry out further examinations if a respondent is found to be suspected of TB based on screening using the SIKRIBO app.
Reviewer #4			
	1	The topic is important especially in Indonesia, but from my perspective there are some concerns for this study. How to use the application is not well presented. For example, provide specific details on how to perform a tuberculosis screening test using the application and how it will help the TB cases' self-care	We have added the details on how to perform a tuberculosis screening test using SIKRIBO through figure 7 In the discussion, we have explained it help the cases' self-care. User can use the SIKRIBO app to for self-screening and increase their knowledge about TB self-care through TB Education menu and Latest Info menu.

	2	It also requires more detailed description of the content development process of the application.	We have added the details on description of the content development process of the SIKRIBO app in “Product design and development” (Method) dan attach the diagram process on Figure 2-4.
	3	And in the discussion section, what significance this application has and how it will benefit public health should be described.	This SIKRIBO as a mobile application that can facilitate health facilities to conduct TB screening in the community by involving the community as cadres. The results of TB screening carried out by cadres will be recorded in the web version of SIKRIBO (Web-based Admin) to monitor cadres in screening and follow up on people suspected of TB for TB diagnosis examinations. Even the public can use it for self-screening. The SIKRIBO app is not only a screening application, but this application is also a medium for public education about TB disease and its prevention provided in the TB Education feature. We have explained it in the discussion.

Date: May 10th, 2022

Editors of Healthcare Informatics Research Journal

1618 Kyungheegung Achim Bldg 3, 34, Sajik-ro 8-gil, Jongno-gu,

Seoul 03174, Korea

Dear HIR Editors,

Hereby it is attested that the manuscript entitled "Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia" to submitted for publication in **Healthcare Informatics Research Journal** has been read and approved by all authors, has not been published elsewhere and that it has not been submitted simultaneously for publication elsewhere in whole or in part in any language.

I confirm that this work is original article and understand that the manuscript may be regarded as redundant or duplicated if the manuscript contains any portion that overlap substantially with information that has already been published. We have no ethical issues and conflicts of interest to disclose.

Thank you for your consideration.

Yours Sincerely,

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Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia

Running Title: SIKRIBO Mobile App for Tuberculosis

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IRB Approval

This research has obtained permission from the Health Research Ethics Commission of the

Public Health Department, Universitas Negeri Semarang number 096/KEPK/EC/2021.

Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia

Abstract

Objectives: This study is conducted to comprehensively document the process of developing and evaluating the usability of the tuberculosis screening application. **Methods:** The Design Science Research Methodology (DSRM) method is used to develop SIKRIBO app, which consists of six steps: problem identification and motivation, definition of objectives for a solution, design and development of products, demonstration, evaluation, and communication. A usability test was performed by using a System Usability Scale (SUS) questionnaire instrument to assess the application's usability. A total of 20 health cadres and health workers participated in the usability tests as research participants. **Results:** The application was developed in two versions: android-based for users and web-based for administrators. The android-based has four main menus: Find Tuberculosis, Tuberculosis Education, Latest Info, and Profile. The web version is accessible to health worker users, as well as the research team and application developers who need to monitor and manage the screening performed by users. According to the usability test, the average SUS score is 76 (SD 8.00). **Conclusions:** This application has been developed to help detecting tuberculosis active cases in the community. The average SUS score shows that the apps is highly usable. So, this application is expected to be implemented in all health facilities to increase the TB case finding rate with active community participation.

Keywords: Mobile Applications, Research Design, Community Participation, Tuberculosis, Internet

I. Introduction

The World Health Organization (WHO) reports that, as of 2019, 10 million people were infected with tuberculosis with 1.2 million deaths [1]. The transmission rate of smear-positive tuberculosis patients is 65%. If one person with active TB can infect 10-15 people, the following year the number of those infected will reach 5.8 million [2].

Indonesia is a country with the highest TB cases by 85% and largest contributor to the global reporting gap of tuberculosis cases by 10% due to low case detection and reporting [1]. As highlighted in the national TB strategy, active case-finding is the primary focus of TB control. The low TB cases found in the community will potentially increase the community's rate of transmission [3].

Rahayu et al. found that one of the factors of TB cases is poor knowledge about the TB symptoms and prevention which contributed to delayed diagnosis [4]. This finding is supported by a longitudinal study which estimated only 52.5% of patients who began treatment were aware that cough was a symptom of TB, while the rest knew little about it. Those with undiagnosed TB act as reservoirs for transmission to their families [5].

The Case Notification Rate (CNR) is one indicator that describes the scope of TB case-finding. The Central Java TB CNR has dropped from 157 per 100,000 population in 2019 to 111 per 100,000 population in 2020 [6]. The TB-CNR in Semarang (the capital city of Central Java province) decreased from 258 per 100,000 population in 2019 to 155 per 100,000 population in 2020. The number of TB case-finding in Semarang in 2019 was 1,653 cases [7].

The Sekaran Public Health Center (PHC) plays a role in finding TB cases that has 329 suspected cases in 2021 [7]. However prevalent, community-based active case-finding has not been carried out actively. Establishing health cadres is one of the efforts of the Sekaran PHC to empower the community in finding TB cases. Cadres selected from the community

are expected to play a central role in improving family health and performing early detection of TB symptoms in their family members to receive a prompt and adequate treatment.

During the COVID-19 pandemic, the tuberculosis program faced numerous challenges, particularly in the case-finding program. This is due to the need to avoid direct contact during the pandemic, especially those with cough symptoms [8]. This direct physical contact can actually be replaced by virtual contact to diminish the risk of exposure. Mobile health (mHealth) applications as a solution in the transformation of health technology to overcome the challenges in TB case-finding [9].

mHealth is the application of technology in the medical world and public health through mobile devices. mHealth technologies include voice and short message services, mobile phone applications, remote monitoring, and portable sensor devices. This technology can also be equipped with geographic information system and global positioning system, which are used for geographic mapping [10].

The use of mHealth has been recognized as an affordable health system innovation that makes high-quality health services accessible to patients in low- and middle-income countries. This includes Indonesia given its poor health systems, high prevalence of tropical and infectious diseases, and high mortality rates [11]. However, the use of mobile phones in Indonesia ranks fourth in the world, 61.7% has access to mobile gadget [12].

There are at least 55 mHealth applications available related to TB treatment [13]. Out of this figure, only 6% of mHealth applications focus on TB screening which is under-researched in scholarly publications [9,13]. TimBre is Indian-based TB apps which focused on cough screening for pulmonary tuberculosis detection. Si Tubo is made in Indonesia which focuses on early detection of tuberculosis symptoms in children [13]. Therefore, the objective of this research is to comprehensively document the process of developing and determining the usability of the tuberculosis screening system (SIKRIBO)

application.

II. Methods

The development of The Tuberculosis Screening System Application (SIKRIBO app) employed Design Science Research Methodology (DSRM) which consist of six activities. This design was chosen because it is more practical and concentrates on developing, implementing, and evaluating the designed artifact with the specific goal of enhancing its functional performance [14]. The detailed steps are presented in Figure 1.

1. Activity 1: Identifying problems and motivation

Preliminary field studies were conducted to identify the challenges associated with finding TB cases.

2. Activity 2: Defining objectives of a solution

At this stage, the objectives of getting a solution from the problem previously identified are determined. The literature reviews were conducted to build on prior research, map the issues and find a solution. There was also a review of studies that evaluated and tested various TB apps. This study is to comprehensively document the process of developing and test the usability of android-based application products that focus on finding TB active cases.

3. Activity 3: Product design and development

SIKRIBO app developed using Rapid Application Development (RAD) method, one of software development life cycle that much faster with higher quality results than other development methodologies (Figure 2) [15].

First stage, the analysis and quick design, the data flow diagram was designed to define how the application works in order to collect and deliver data to be information as the output (Figure 3). Interaction of agents as user, the application as a tool and the response of the respondents are the main concern of this application to be focused to. As the objective of this

application that is gathering as early as possible case finding of TB in the community, this app has to be well designed to accomodate interaction between the entities. The class diagram was designed in Figure 4 to define every entity's properties and actions while this application is being used.

This application was developed on Android platform using and open source mobile application development framework called Flutter. Android was chosen because it covers almost all of the market share mobile application in Indonesia, it has 90.84% market share of Indonesian mobile phone users [15]. Backend web-based admin portal was developed using Laravel framework, one of the most popular PHP Framework recently. After the cycle of prototyping processes done, the next stage is testing the application to the sample of the users through three stages: internal trials, expert validity and black box testing that is described on activity 4. At the end of the development process, the app is deployed to a shared hosting and registered to a domain so that the application can be accessed publicly.

4. Activity 4: Demonstrations

This activity includes a simulation of running the application prototype.

1) Internal trial

By analyzing the internal workings and structure of a software, white box testing can uncover system implementation errors such as poor key management. The path coverage technique was used to test application in order to see the cyclometic complexity in the system.

2) Expert validity

Expert validity was carried out through a trial of application products by media experts and Public Health experts. A questionnaire in the form of a validation sheet was distributed to assess, validate, and evaluate the application.

3) Black-box test

Black Box Testing is software testing that only observing the fundamental aspects of the

system to ensure that any specified system function or input is fully operational. This trial stage conducted by health workers of Sekaran PHC acting as administrators and users. The Black-Box test results show that the application runs optimally and can be used accordingly and reliably.

5. Activity 5: Evaluation (Usability Test)

This app is evaluated using a usability test. This test is to determine the extent to which users can use a product to achieve specific goals by taking into account the effectiveness, efficiency, and satisfaction of using a product [16].

1) Research Population and Design

This study used a cross sectional design to determine the usability of SIKRIBO app. The sample population in this study were health cadres and health workers at Sekaran PHC, Semarang whose age ranges from 17-65 years.

2) Determination of Sample Size

A total of 20 respondents were chosen as representatives of usability trials. The number of samples is chosen based on the findings of Nielsen (2004) [17]. This sample selection was done by convenience sampling technique, which is the most frequently used method in usability studies [17]. The sample is health cadres and PHC workers aged 17-65 years who are the target users of SIKRIBO in the future, to carry out TB screening for the general public. Sampling was carried out at the Sekaran PHC in Semarang as a pilot health center.

3) Research Instrument

This study used the System Usability Scale (SUS) instrument to test the usability of the SIKRIBO app. The SUS was chosen because it has been well validated as a measure of the mobile applications usability in questionnaire-based studies [18,19] and has proven to be very valid in various previous studies [19]. SUS in this study which has been adapted into Indonesian language, validated, and reliability (Cronbach Apha: 0.841) [16]. Besides, a kappa

analysis was carried out to measure the level of approval of the SUS instrument by two raters with the results of a fairly high kappa value, or moderate agreement (Kappa: 0.494).

The SUS consisted of 10 statement items with odd number patterns for positive statements and even numbers for negative statements. In this study, the measurement scale is categorized into 3 point scales, namely positive, neutral, and negative. More specifically, the points are classified as positive responses if they choose a score of 5 or 4 for odd items (positive statements) and scores of 1 or 2 for even items (negative statements); neutral if they choose a score of 3; and negative if the they choose a score of 1 or 2 for odd items and a score of 5 or 4 for even items. Based on the Muhamat et. al research (2021), this categorization is carried out to overcome the occurrence of habitual bias in respondents who are involved in measuring the usability of this application [18].

For positive statement of SUS scores, the score contribution is scale position minus 1 and for negative statements, the score contribution is 5 minus scale position. The overall SUS score is the result of adding up the contribution of the item scores multiplied by 2.5, ranging from 0 to 100. A product is considered to have good usability and high acceptance if the overall SUS score is equal to or above 68 [18].

4) Data Collection

The respondents were asked to install the SIKRIBO app on each smartphone device by downloading it via Google Play™. They were assigned to operate the SIKRIBO app in all its functions, include conducting TB screening independently and among other respondents. After that, respondents were asked to evaluate by filling out the SUS questionnaire.

5) Data Analysis

The data of SUS were calculated by using Microsoft® Excel® and analyzed by using data analysis software, IBM® SPSS® Statistics Version 26..

6) Ethical Considerations

This research was approved by Health Research Ethics Commission, Department of Public Health, Semarang State University (No.096/KEPK/EC/2021) and all participants required to sign an informed consent.

III. Result

1. Product Design and Development

The tuberculosis screening application is divided into two versions:

1) Client Based on Android

The Android version is used to collect patient screening data. It has four main menus demonstrated in Figure 5:

(1) Find TB

It is an early tuberculosis screening form that cadres must fill out when screening TB in the community. The TB screening form contains 10 questions regarding TB symptoms based on WHO [20]. If the respondent feels one of these symptoms, it will be categorized as a person with suspected TB. This menu includes a personal data form for the person being screened. The results of screening can be seen in the "Profile" menu with status "Healthy" or "Suspect". The steps for TB screening with this application are shown in Figure 7:

(2) TB Education

The menu contains TB-related information. This menu is expected to provide the community with insight and knowledge about TB disease.

(3) Latest Info

This menu displays various kinds of the latest information about TB disease. The information was obtained from various trusted sources which are expected to provide updated information about TB and prevent the spread of hoax on TB in the community.

(4) Profile

When a user logs in with a Google™ account, the Profile menu will automatically display user data in the form of name and email address. This profile update is expected to provide information to PHCs regarding the personal data of the data input (user), with the goal of maintaining communication in the future regarding the ongoing TB screening follow-up.

2) Web-Based Admin

The web version is accessible to health worker users, as well as the research team and application developers who need to monitor and manage the screening performed by users (Figure 6).

2. Evaluation (Usability Testing)

1) Socio-Demographic Characteristic

Usability testing was carried out on 20 participants with the demographic characteristics presented in Table 1. The majority of participants are in the age group of 17-25 years (40%). Most of the respondents have the last education at the tertiary level with a percentage of 70% and 90% of respondents are female.

2) Usability Testing

Usability testing is used to discover and troubleshoot any errors made by users when using mobile-based applications. Based on Table 2, almost all statements have a higher proportion of positive responses. Statements number 1 and 7 have the highest percentage of positive responses (95%). For Statement number 10 has the highest percentage of negative responses, it is 50%. The highest average score is in the 3rd statement regarding the user-friendliness of the application with a score of 3.4 (SD 0.68) and the lowest average score is 1.7 (SD 1.22) in statement no 10 related to self-adjustment before use the app. The SUS score is 76, which is higher than the system's minimum usability score (68). These results indicate that the

application has a high acceptability and good usability**.** The results of the usability score in more detail are shown in the chart in Figure 8.

IV. Discussion

According to the usability testing, the level of user satisfaction with the SIKRIBO app is relatively high. It shown that most of the respondents think they will use it again. This respondent's desire is because of the ease of use of this application. The high number of users who intend to use this application again in the future is a good sign, because user retention is a challenge in the development and implementation of mHealth [21]. According to Muhamat et al. (2021), an easy-to-use mobile application will be related to the user's intention to use it again [18]. The respondents also agreed that the features available in the SIKRIBO app run properly and are well integrated. In fact, almost all respondents gave a positive response if they imagine this application is used by most people will be quick to use this application. This is possible because the SIKRIBO app was developed with simple and common features found in mobile applications, so that users can easily understand. In line with another goal of developing the SIKRIBO app, namely developing a TB screening application that is friendly to use by people from various circles.

Furthermore, half of the respondents said that it was necessary to learn a lot of things before before using this application. These findings are consistent with the findings of Pande et al. (2017), who discovered that as many as 50% of respondents gave a negative response about that. This is understandable given that new technology necessitates user adaptation [22]. One of the challenges in implementing mHealth is taking the time to study the app before deploying it. Experts must explain the benefits of using the application to users before they are willing to adopt it into their clinical practice [23].

The SUS score is 76 (SD 8.00), which means that this application has good usability.

Idrus et al. (2020) shared similar finding where the average SUS score on web-based HIV and tuberculosis therapy management applications was 77.7 [24]. Another study found that the average SUS score on mHealth was 80.5 (SD 11.47), indicating that the application has good but not excellent usability. The higher the SUS score, the more acceptable and good the system [25].

The main purpose of developing the SIKRIBO app is to assist in increasing TB case detection in the community as early as possible by utilizing digital technology. Screening through symptoms is an easy way to screen TB cases in the community. Moreover, involving the community in TB screening will increase TB case finding. This SIKRIBO app carries out this mission as a mobile application that can facilitate health facilities to conduct TB screening in the community by involving the community as cadres. The results of TB screening carried out by cadres will be recorded in the web version of SIKRIBO (Web-based Admin) to monitor cadres in screening and follow up on people suspected of TB for TB diagnosis examinations. Even the public can use it for self-screening.

The use of mHealth in public health can help screen for infectious diseases and strengthen infectious disease surveillance in several countries. In addition, it has the potential to increase the availability of scientific research and public health [26]. Even in the perspective of health workers reported by Faudjar et. al (2021) it shows that work is getting easier and faster with the existence of a Health digital system, although it takes a long time to adapt [27]. The SIKRIBO app is not only a screening application, but this application is also a medium for public education about TB disease and its prevention provided in the TB Education feature. Proven in Mahmood et. al's (2019) research where health education on disease and its prevention becomes more efficient through smartphones [28]. Seeing the great benefits in public health, this application will be developed in a large trial as a first step and can be utilized by various primary health facilities.

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Table 1. Socio-Demographic Characteristics (n = 20)

Variables	Frequency
	n (%)
Age (years)	
17-25	8 (40.0)
26-35	5 (25.0)
36-45	4 (20.0)
46-55	2 (10.0)
56-65	1 (5.0)
Education Level	
Elementary School	1 (5.0)
Junior High School	1 (5.0)
Senior High School	4 (20.0)
College	14 (70.0)
Gender	
Male	2 (10.0)
Female	18 (90.0)

Table 2. Usability Testing (n = 20)

No.	Statement	Responses			Mean Score (SD)
		Positive	Neutral	Negative	
		n (%)	n (%)	n (%)	
1.	I think that I would like to use this application	19 (95.0)	1 (5.0)	-	3.3 ± 0.6
2.	I found application unnecessarily complex	17 (85.0)	3 (15.0)	-	3.1 ± 0.6
3.	I thought application was easy to use	18 (90.0)	2 (10.0)	-	3.4 ± 0.7
4.	I think that I would need the support of a technical person to be able to use application	15 (75.0)	3 (15.0)	2 (10.0)	4.0 ± 1.1
5.	I found the various functions in application were well integrated	18 (90.0)	2 (10.0)	-	3.2 ± 0.6
6.	I thought there was too much inconsistency in application	16 (80)	2 (10.0)	2 (10.0)	3.0 ± 0.9
7.	I would imagine that most people would learn to use application very quickly	19 (95.0)	1 (5.0)	-	3.4 ± 0.6
8.	I found application very cumbersome to use	16 (80.0)	3 (15.0)	1 (5.0)	3.1 ± 1.0
9.	I felt very confident using application	18 (90)	2 (10)	-	3.4 ± 0.7
10.	I needed to learn a lot of things before I could get going with application	5 (25.0)	5 (25.0)	10 (50.0)	1.7 ± 1.2
Total Responses		161 (80.5)	24 (12.0)	15 (7.5)	
SUS[a] Score (SD)		**76 (8.0)**			

a. System Usability Scale (SUS)

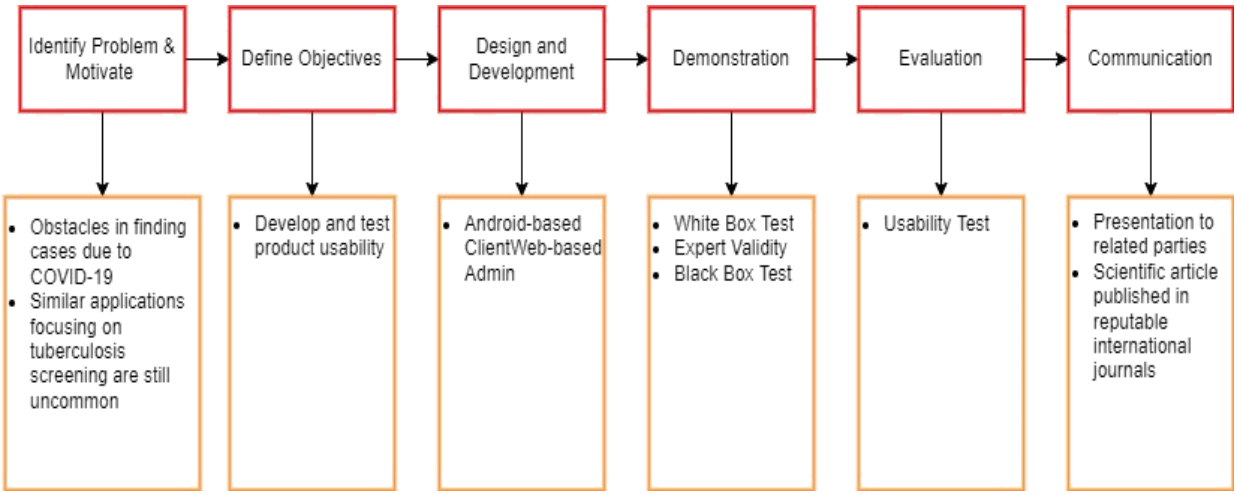

Figure 1. DSRM Process Model on SIKRIBO Application

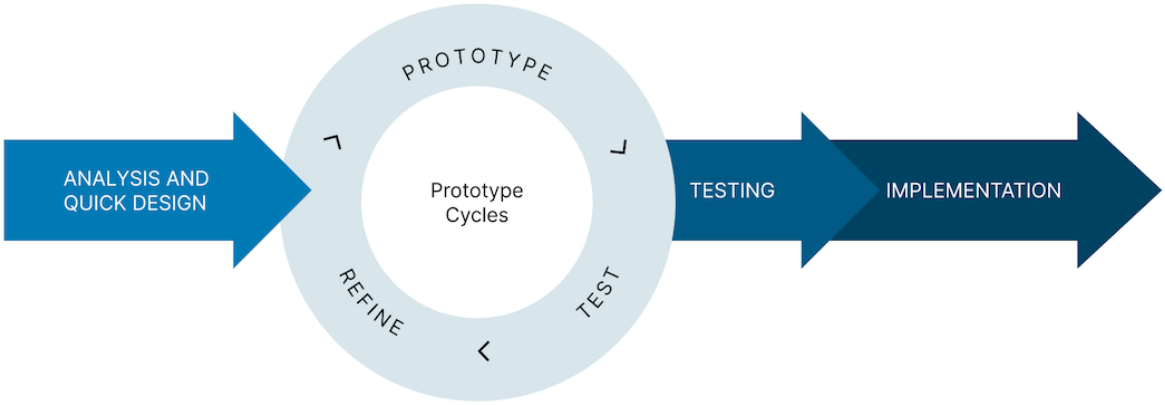

Figure 2. Development stages of RAD methodology

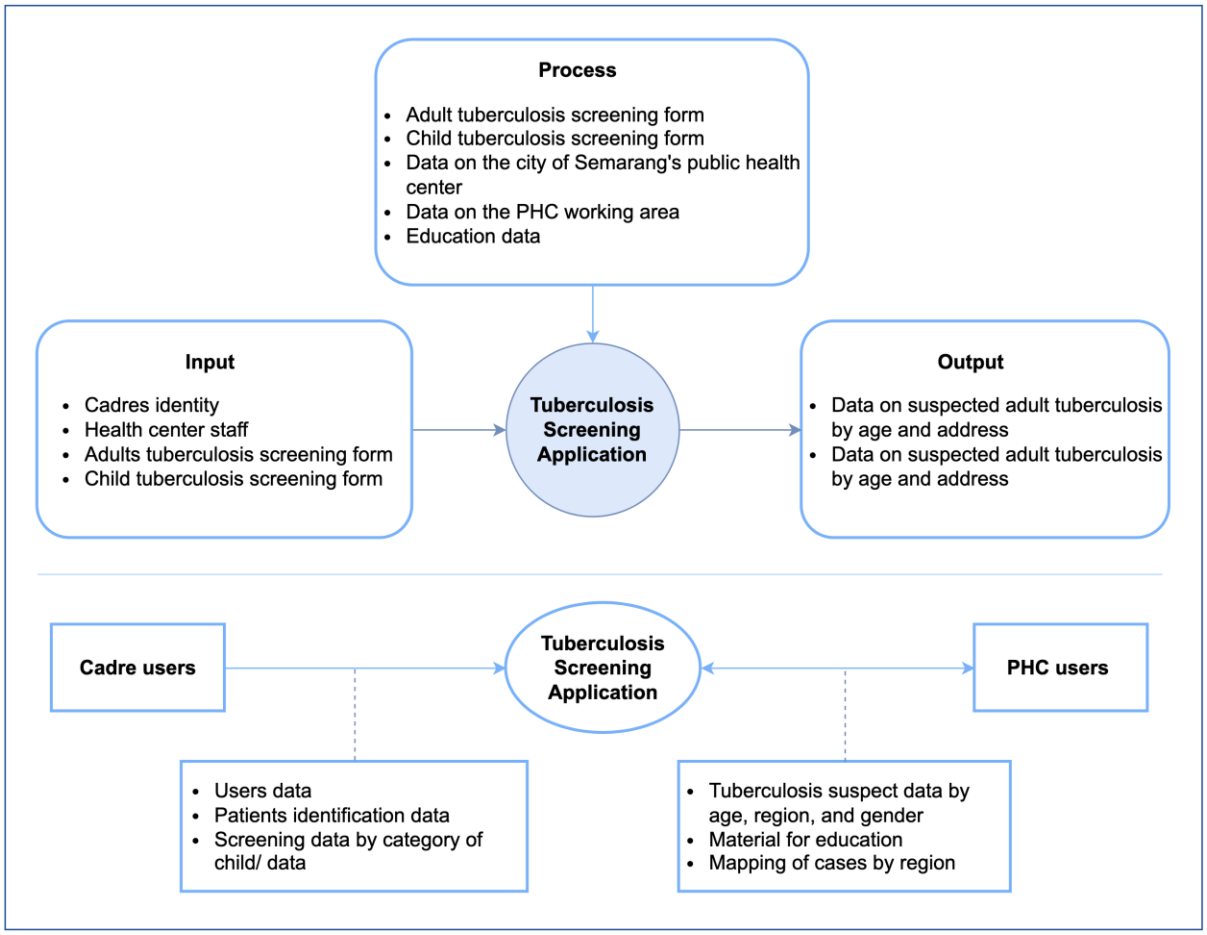

Figure 3. Data Flow Diagram on the SIKRIBO Application

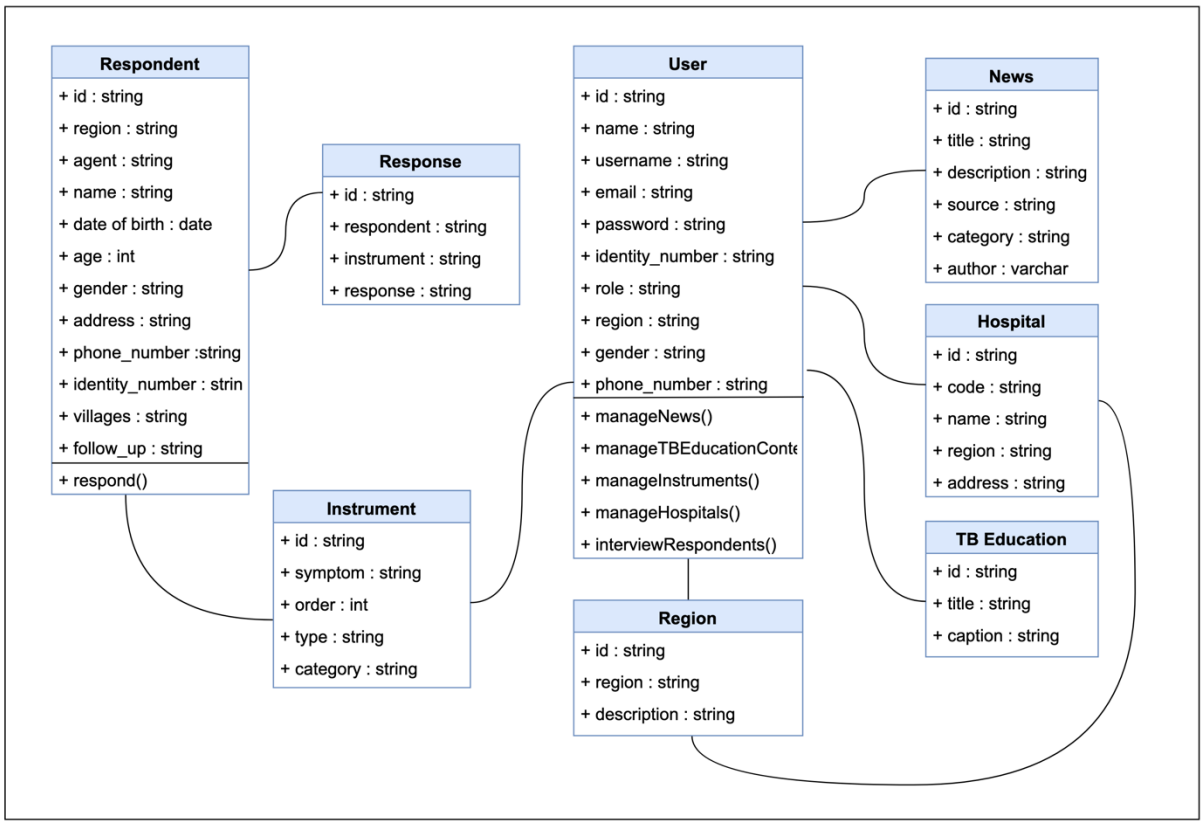

Figure 4. Design of class diagram of the SIKRIBO Application

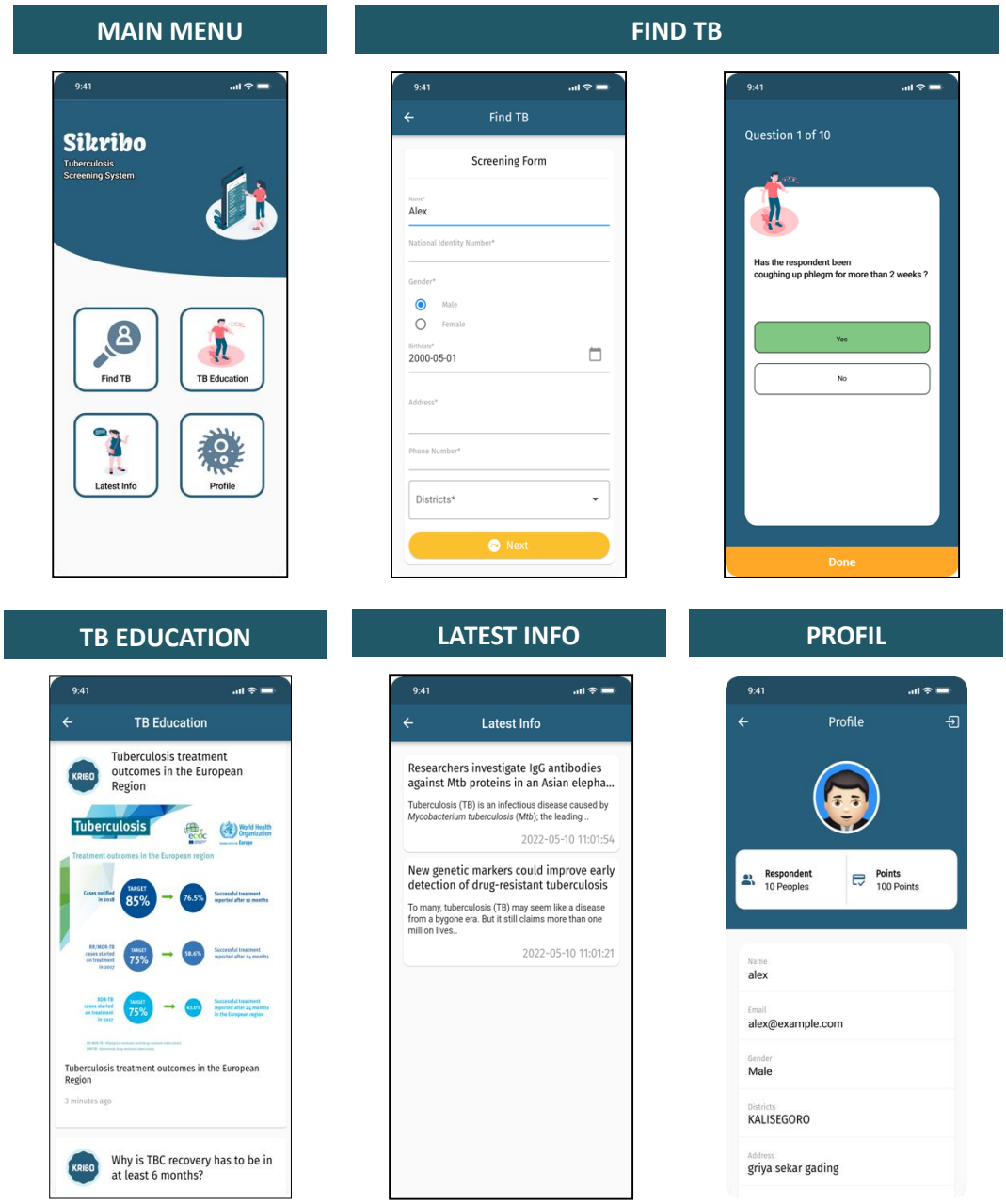

Figure 5. Display Menus Client Based on Android: 1) Main menu; 2) Find TB; 3) TB Education; 4) Latest Info; 5) Profile

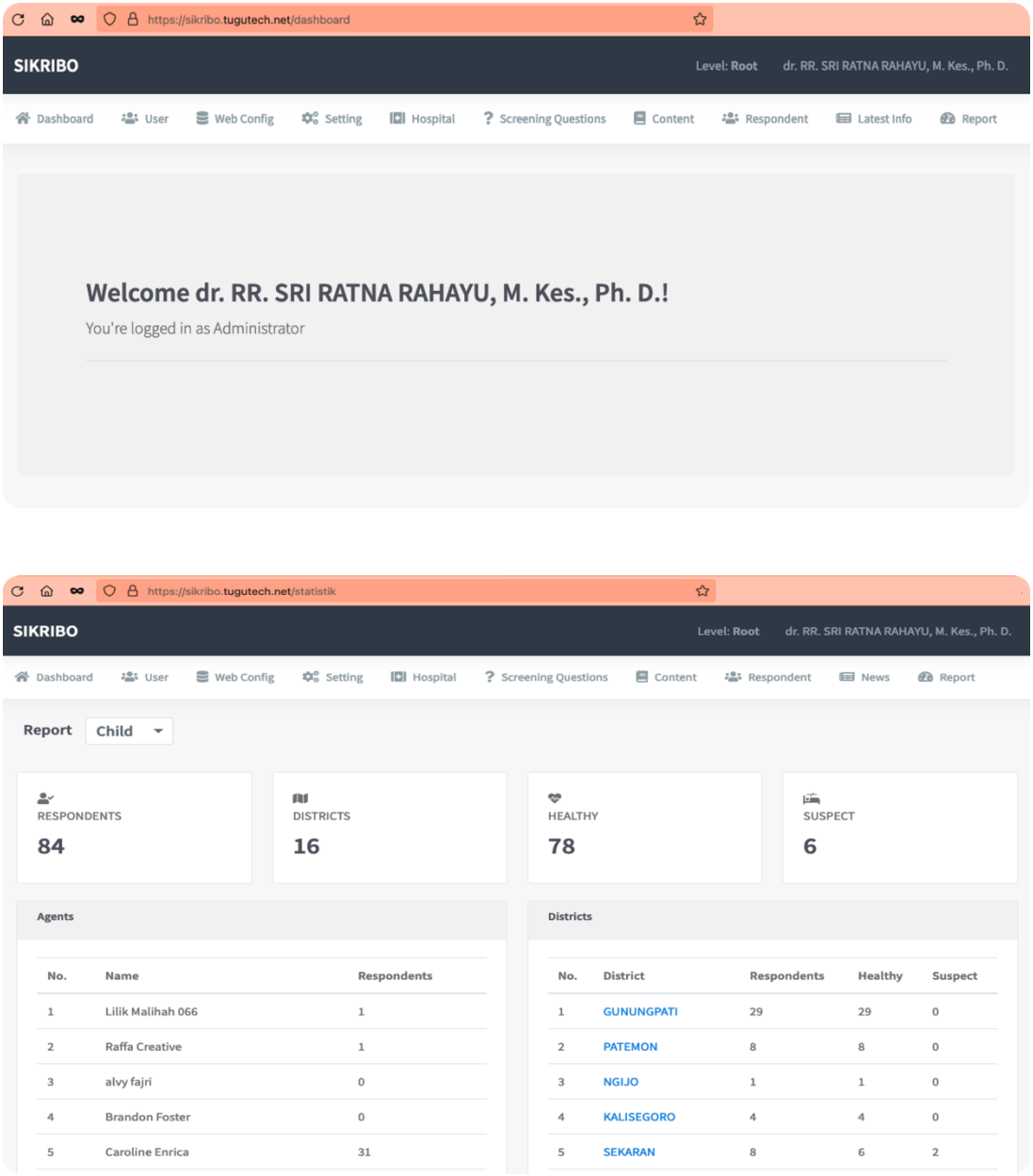

Figure 6. Web-Based Admin Display

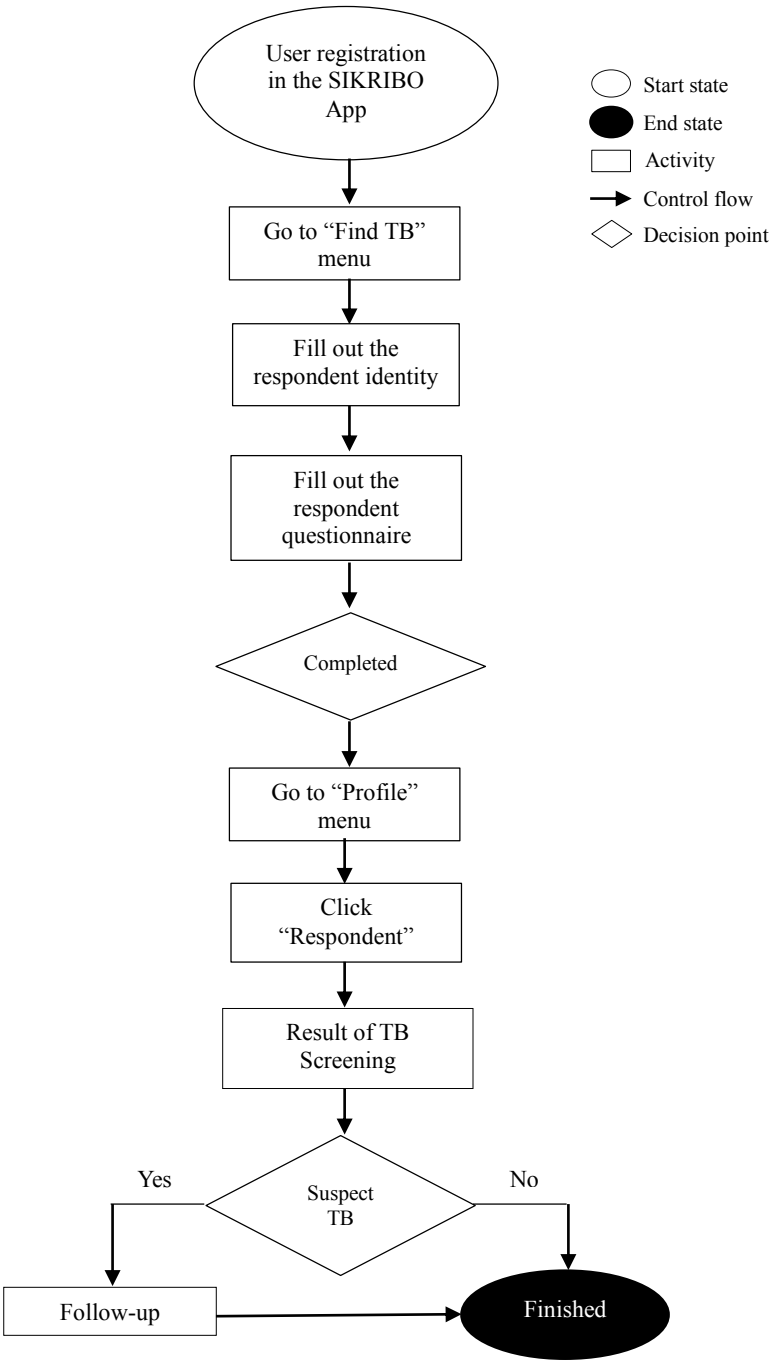

Figure 7. Flowchart of TB screening using SIKRIBO Application

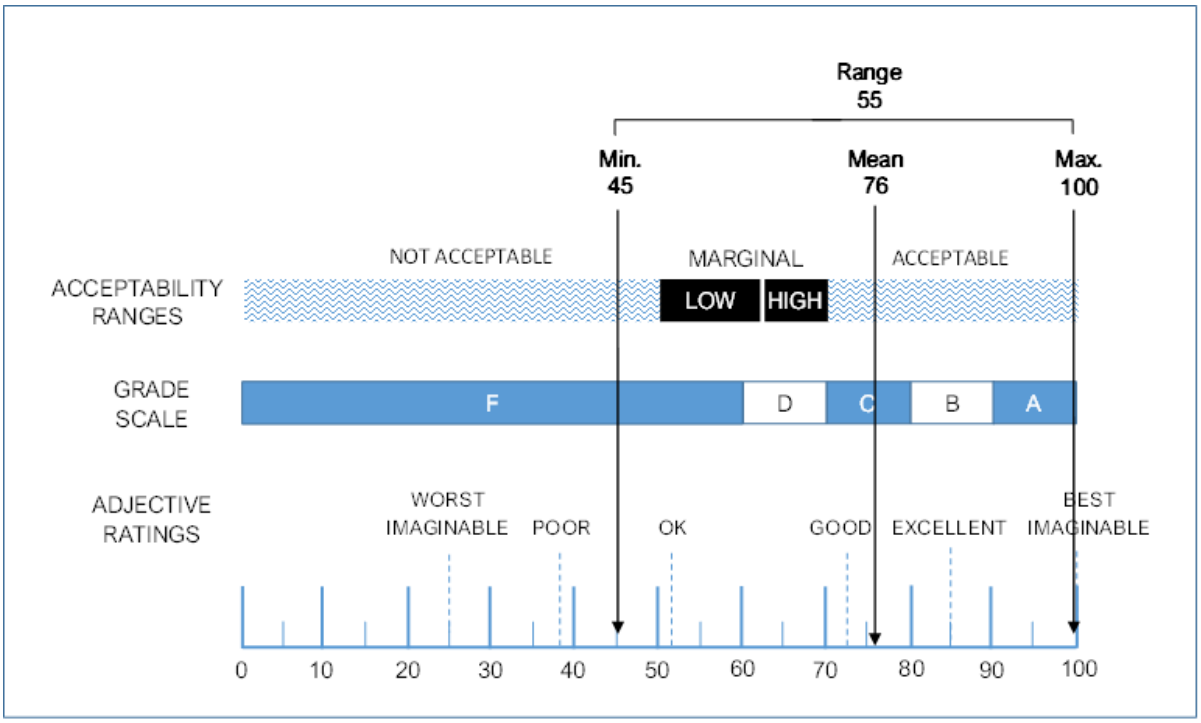

Figure 8. Overview of modified SUS rating table with inserted value [24].

8. Bukti konfirmasi artikel accepted (24 Agustus 2022)

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RR. SRI RATNA RAHAYU <sriratnarahayu@mail.unnes.ac.id>

Manuscript No. [HIR-22-041R1] Letter of decision

2 messages

Healthcare Informatics Research <em@editorialmanager.com> Wed, Aug 24, 2022 at 6:21 PM
Reply-To: Healthcare Informatics Research <hir@kosmi.org>
To: Sri Ratna Rahayu <sriratnarahayu@mail.unnes.ac.id>

Ref.: Ms. No. HIR-22-041R1
Development of the SIKRIBO Mobile Health Application for Tuberculosis Active Case Finding in Semarang, Indonesia
Healthcare Informatics Research

Dear Mrs. Rahayu,

I am pleased to tell you that your work has now been accepted for publication in Healthcare Informatics Research .

It was accepted on Aug 24, 2022

Comments from the Editor and Reviewers can be found below.

Thank you for submitting your work to this journal.

With kind regards,

Hyejung Chang, Ph.D.
Editor-in-Chief
Healthcare Informatics Research

Comments from the Editors and Reviewers:

Editor: Reviewer #1: The authors of the SIKRIBO mobile health application have reviewed and corrected all comments and observations.

This study is an important topic for HIR journal. Finally, the SUS score shows that it is highly usable. Therefore, it is expected that this application will be implemented in all health facilities to increase the detection rate of TB cases with the active participation of the community.

Reviewer #3: Comments to author,

You have explained the main issues relatively well. Thank you.

I would appreciate it if you could submit a good research study in the future.

Best regards,

RR. SRI RATNA RAHAYU <sriratnarahayu@mail.unnes.ac.id> Tue, Aug 30, 2022 at 9:50 AM
To: Healthcare Informatics Research <hir@kosmi.org>

Editor-in-Chief
Healthcare Informatics Research
Hyejung Chang, Ph.D.

Dear Editor,

Thank you for considering and accepting our research article for publication in Healthcare Informatics Research.

Then, what is the next step we should do? Thank you.

With kind regards,

Author,
Sri Ratna Rahayu, (dr., M.Kes., Ph.D)

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9. Bukti konfirmasi proses editing manuskrip dari Editor (20 Oktober 2022)

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[HIR-22-041] Manuscript editing is completed

4 messages

HIR <hir@kosmi.org> Thu, Oct 20, 2022 at 2:07 PM
Reply-To: HIR <hir@kosmi.org>
To: sriratnarahayu@mail.unnes.ac.id

Dear Mrs. Rahayu:

We are attaching a manuscript edited file. Please check it out carefully, especially the manuscript editor's memos, let me know the parts you want to modify.

This proof stage is not a time for extensive corrections, additions, or deletions.
It is advised that editing is limited to the correction of typographical errors, incorrect data, and grammatical errors, and for updating information on references which were in press.

We have also done English proofreading for the main text, therefore please check that there are any changes in meaning.
I'm attaching the file for your information. (You need not send me this file back.)

We look forward to hearing your response **within 48 hours**.
*** Please write corrections in this file **★HIR-22-041.docx**.***

Do not hesitate to contact me if you have any questions.
Thank you.

The Editorial Office

Healthcare Informatics Research

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Healthcare Informatics Research

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RR. SRI RATNA RAHAYU <sriratnarahayu@mail.unnes.ac.id> Sat, Oct 22, 2022 at 5:25 AM
To: HIR <hir@kosmi.org>

Original

Development of the SIKRIBO Mobile Health Application for Active Tuberculosis Case Detection in Semarang, Indonesia

Sri Ratna Rahayu[1], Intan Zainafree[1], Widya Hary Cahyati[1], Eko Farida[1], Aufiena Nur Ayu Merzistya[2], Anggun Dessita Wandastuti[3], Isbandi[1], Nur Wahidah[2], Muhamad Zakki Saefurrohim[1], Muhamad Anbiya Nur Islam[4], Alvy Fajri[4], Mona Subagja[4] [A1]

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Running Title: SIKRIBO Mobile App for Tuberculosis

Abstract

Objectives: This study was conducted to document the development and usability testing of SIKRIBO, a tuberculosis screening application.

Methods: The SIKRIBO application was developed using design science research methodology, which has six steps: problem identification and motivation, definition of objectives for a solution, product design and development, demonstration, evaluation, and communication. A system usability scale (SUS) questionnaire was used to assess application usability. A total of 20 health cadres (trained community members) and health workers participated in the usability tests.

Results: Two versions of the application were developed: Android-based for users and web-based for administrators. The Android-based version has four main menus: Find Tuberculosis, Tuberculosis Education, Latest Info, and Profile. The web version is accessible to health workers, as well as the research team and application developers who monitor and manage the user-conducted screenings. The average SUS score was 76 (standard deviation, 8.00).

Conclusions: This application was developed to help detect active tuberculosis cases in the community. The SUS results indicate that the application is highly usable. Thus, SIKRIBO is expected to be broadly implemented to increase tuberculosis case detection through active community participation.

Keywords: Mobile Applications, Research Design, Community Participation, Tuberculosis, Internet

I. Introduction

The World Health Organization reported that in 2019, 10 million people were infected with tuberculosis (TB) and 1.2 million died [1]. The transmission rate of smear-positive tuberculosis patients is 65%, and if a single person with active TB can infect 10 to 15 people, there would be 5.8 million infections within a year [2].

Indonesia has one of the highest TB case counts in the world, and the nation accounts for 10% of the global reporting gap of tuberculosis cases due to low case detection and reporting [1].[A2] As highlighted in the national TB strategy, active case-finding is the primary focus of TB control. Poor TB case detection in a community may increase that community's transmission rate [3].

Rahayu et al. [4] found that a lack of knowledge about TB symptoms and prevention contributes to delayed diagnosis. A separate longitudinal study indicated that only 52.5% of patients who began treatment were aware that cough was a symptom of TB. Those with undiagnosed TB act as reservoirs for transmission to their families [5].

The case notification rate (CNR) is an indicator of the scope of TB case detection. The Central Java TB CNR fell from 157 per 100,000 population in 2019 to 111 per 100,000 population in 2020 [6]. The TB CNR in Semarang (the capital city of Central Java Province) decreased from 258 per 100,000 population in 2019 to 155 per 100,000 population in 2020. In 2019 in Semarang, 1,653 TB cases were identified [7].

The Sekaran Public Health Center (PHC) identified 329 suspected TB cases in 2021 [7]. However prevalent the disease, community-based case-finding has not been conducted actively. One initiative of the Sekaran PHC involves the selection of individuals, termed health cadres, to empower the community in identifying TB cases. These community members can play a central role in family health and are trained for the early detection of TB symptoms in their

family members, allowing for prompt and adequate treatment.

The coronavirus disease 2019 pandemic brought numerous challenges to tuberculosis treatment efforts, particularly in case detection. Direct contact had to be avoided, especially with individuals with cough symptoms [8]. However, direct physical contact can be replaced by virtual contact to diminish the risk of exposure. Mobile health (mHealth) applications are therefore a potential solution to the challenges in TB case-finding [9].

mHealth is the application of technology in medicine and public health through mobile devices. mHealth technologies include voice and short messaging services, mobile phone applications (or apps), remote monitoring, and portable sensors. This technology can also be equipped with geographic information and global positioning systems for geographic mapping [10].

mHealth has been recognized as an affordable innovation that can bring high-quality health services to patients in low- and middle-income countries. These countries include Indonesia, due to its poor health systems, high prevalence of tropical and infectious diseases, and high mortality [11]. However, Indonesia ranks fourth in the world in the use of mobile phones, with 61.7% of the population having access to a mobile device [12].

At least 55 mHealth applications related to TB treatment are available [13]. However, only 6% of these[A3] focus on TB screening, which is underrepresented in the literature [9,13]. One example, TimBre, is an Indian-based TB app designed for cough screening for the detection of pulmonary tuberculosis. Another, Si Tubo, was made in Indonesia and facilitates the early detection of tuberculosis symptoms in children [13]. The objective of this study is to present comprehensive documentation of the development and usability testing of SIKRIBO, a tuberculosis screening application.

II. Methods

The SIKRIBO application was developed using design science research methodology. This approach provides a practical framework for developing, implementing, and evaluating the designed artifact with a focus on enhancing functional performance [14]. The six activities of this methodology are explained as follows and detailed in Figure 1.

1. Identifying Problems and Motivation

Preliminary field studies were conducted to identify the challenges associated with detecting TB cases.

2. Defining Objectives of a Solution

Literature reviews were conducted to build on prior research, map the issues, and determine a solution. Additionally, studies of the evaluation and testing of various TB apps were reviewed. The goal was to document the development and usability testing of Android-based applications for the detection of active TB cases.

3. Product Design and Development

The SIKRIBO app was created using rapid application development, which produces higher-quality results much faster than other software development methodologies [15] (Figure 2).

In the first stage (analysis and quick design), a data flow diagram was created to define how the application collects and delivers data (Figure 3). The application involves interactions between agents as users, the application as a tool, and the responses of the respondents; to accommodate these interactions smoothly, the application must be well-designed. A class diagram (Figure 4) was also created to define the properties and actions of each entity using the app.

This application was developed on the Android platform using Flutter, an open-source mobile

application development framework. Android was chosen based on its 90.84% market share of Indonesian mobile phone users [15]. A backend web-based admin portal was developed using Laravel, one of the most popular PHP frameworks. After a cycle of prototyping, the application was subjected to three stages of user testing: internal trials, expert validity, and black-box testing (described in Section II-4). Finally, the app was deployed to a shared hosting environment and registered to a domain to allow public access.

4. Demonstration

This activity includes simulated running of the application via a prototype.

1) Internal trials

By analyzing the internal structure of a software program, white-box testing can uncover system implementation errors, such as poor key management. Path coverage testing was used to understand the cyclomatic complexity of the system.

2) Expert validity

Expert validity was attained through a trial of application products by media experts and public health professionals. A validation sheet questionnaire was distributed to assess and validate the application.

3) Black-box testing

Black-box testing involves observing only the fundamental aspects of the system to ensure that any specified system function or input is fully operational. In this stage, health workers of Sekaran PHC acted as administrators and users. The black-box test results showed that the application runs well and can be used reliably.

5. Evaluation (Usability Testing)[A4]

Usability testing is used to determine the extent to which a product allows users to achieve specific goals. The effectiveness, efficiency, and satisfaction of using a product are considered [16].

1) Research population and design

A[A5] cross-sectional design was used to evaluate the usability of the SIKRIBO app. The sample population included health cadres and health workers at Sekaran PHC in Semarang whose ages ranged from 17–65 years. The sample was designed to reflect the target users of SIKRIBO, who will be conducting TB screening for the public.

2) Sample size determination

Based on the findings of Nielsen (2004), [A6]20 respondents were chosen for the usability trials [17]. The sample was selected via convenience sampling, which is the most common method for usability studies [17]. Sampling was carried out at the Sekaran PHC in Semarang as a pilot health center.

3) Research instrument

The system usability scale (SUS) was chosen for the usability testing of the SIKRIBO app. This instrument is a well-validated measure of mobile application usability in questionnaire-based studies [18,19]. The SUS used in this study had been adapted into the Indonesian language, validated, and evaluated for reliability (Cronbach $\alpha = 0.841$) [16]. Additionally, a kappa analysis of the SUS instrument was conducted to measure the agreement between two raters; this yielded a fairly high kappa value ($\kappa = 0.494$), indicating moderate agreement.

The SUS consisted of 10 statement items with favorable[A7] odd-numbered statements and unfavorable even-numbered statements. Responses were categorized as positive, neutral, or negative. Responses were considered positive if the respondent chose a score of 5 or 4 for odd items (favorable statements) or a score of 1 or 2 for even items (unfavorable statements), neutral if a score of 3 was selected, and negative if the respondent chose a score of 1 or 2 for odd items or a score of 5 or 4 for even items. Per Akmal Muhamat et al. [18], this system can counteract habitual bias in respondents.

For the favorable items, the individual item score was the scale position minus 1, and for the unfavorable items, the item score was 5 minus the scale position. The overall SUS score (ranging from 0 to 100) was obtained by adding the item scores and multiplying by 2.5. A product is considered to have good usability and high acceptance if the overall SUS score is 68 or higher [18].

4) Data collection

The participants were asked to install the SIKRIBO app on a smartphone by downloading it via the Google Play Store. They were told to utilize all functions of the application, including conducting TB screening independently and with other respondents. Participants were then asked to complete the SUS questionnaire.

5) Data analysis

The SUS results were calculated using Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) and analyzed using SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA) software.

6) Ethical considerations

This study was approved by the Health Research Ethics Commission of the Department of

Public Health at Semarang State University (No. 096/KEPK/EC/2021). All participants provided informed consent.

III. Results

1. Product Design and Development

The tuberculosis screening application has two versions.

1) Client-based on Android

The Android version is used to collect patient screening data. It has four main menus, shown in Figure 5.

(1) Find TB

This is a form that cadres must complete when performing early screening for TB in the community. The TB screening form contains 10 questions about TB symptoms based on the World Health Organization guidelines [20]. An individual with one of these symptoms is categorized as having suspected TB. This menu includes a personal data form for the person being screened. The screening results (healthy or suspect) can be seen in the Profile menu. Figure 6 [A8]shows the steps for TB screening with this application.

(2) TB Education

This menu contains TB-related information, intended to provide the community with knowledge about the disease.

(3) Latest Info

This menu displays the latest information about TB. The information was obtained from trusted sources that are expected to provide updated information about TB to combat the spread of TB-related hoaxes in the community.

(4) Profile

When a user logs in with a Google account, the Profile menu automatically displays that user's name and email address. The goal is to provide user data to PHCs to help maintain future communication regarding TB screening follow-up.

2) Web-based Admin

The web version is accessible to health workers, as well as the research team and application developers who monitor and manage the user-conducted screenings (Figure 7).

2. Evaluation (Usability Testing)

1) Sociodemographic characteristics

Usability testing included 20 participants with the demographic characteristics presented in Table 1. The most common age range for participants was 17–25 years old (40%). The highest education level of most respondents was the tertiary level (70%), and 90% of respondents were female.

2) Usability testing

Usability testing can be used to uncover and troubleshoot any unintended actions taken by users of mobile-based applications. As shown in Table 2, almost all statements had more positive than negative responses. Statements 1 and 7 had the highest percentage of positive responses (95%). Statement 10 had the highest percentage of negative responses, at 50%. The highest average score was for the third statement, about the user-friendliness of the application, at 3.4 (standard deviation [SD], 0.68), and the lowest average score was 1.7 (SD, 1.22) for statement 10, related to self-adjustment before app use. The SUS score was 76, which exceeds the system's minimum usability score (68). The application thus has high acceptance and good

usability. The usability score results are detailed in Figure 8.

IV. Discussion

Participants in the usability test displayed relatively high satisfaction with the SIKRIBO app. Most respondents indicated that they would use the application again, due to its ease of use. This finding is promising because user retention is a challenge in the development and implementation of mHealth [21]. According to Akmal Muhamat et al. [18], the ease of use of a mobile application is associated with the user's intention to use it again. The respondents also agreed that the SIKRIBO application features run properly and are well integrated. In fact, almost all respondents agreed that most people would quickly learn how to use this application. This is possible because the SIKRIBO app was developed with easily understandable features common in mobile applications, with the goal of facilitating broad user-friendliness.

However, one-half of the respondents reported that a steep learning curve was required before using the application. This aligns with the findings of Pande et al. [22], in which as many as 50% of respondents provided a similar response. This is understandable given that new technology necessitates user adaptation. One challenge in implementing mHealth is taking the time to study the app before deploying it. Experts must be able to explain the benefits of the application to users before they are willing to adopt it into clinical practice [23].

The higher the SUS score, the more usable the system. In the present study, the mean SUS score was 76 (SD, 8.00), indicating good usability. Similarly, Idrus et al. [24] found an average SUS score of 77.7 for web-based human immunodeficiency virus and tuberculosis therapy management applications. In another study, the average mHealth SUS score was 80.5 (SD, 11.47), indicating good but not excellent usability [25].

The main purpose of the SIKRIBO app is to assist in early TB case detection in the community

by utilizing digital technology. Screening through symptoms is an easy way to identify TB cases in the community. Moreover, involving the community in TB screening increases the rate of TB detection. The SIKRIBO app can help health facilities conduct TB screening in the community by involving the community as cadres. The results of these screenings are recorded in the web-based admin version of SIKRIBO to monitor cadres in screening and follow-up suspected TB cases for diagnostic examinations. Even the public can use SIKRIBO for self-screening.

mHealth can be used to help screen for infectious diseases and strengthen infectious disease surveillance across the globe. In addition, it may increase the availability of scientific research and public health initiatives [26]. Even from the perspective of health workers, as reported by Faudjar et al. [27], such digital systems are making work easier and faster, although adaptation can be slow. The SIKRIBO app is not only a screening application, but also a medium for public education about TB and its prevention, provided in the TB Education feature. Mahmood et al. [28] underscored that smartphones increase the efficiency of health education on disease and its prevention. In line with these potentially great benefits in public health, the SIKRIBO application should be released in a large initial trial for utilization by primary health facilities.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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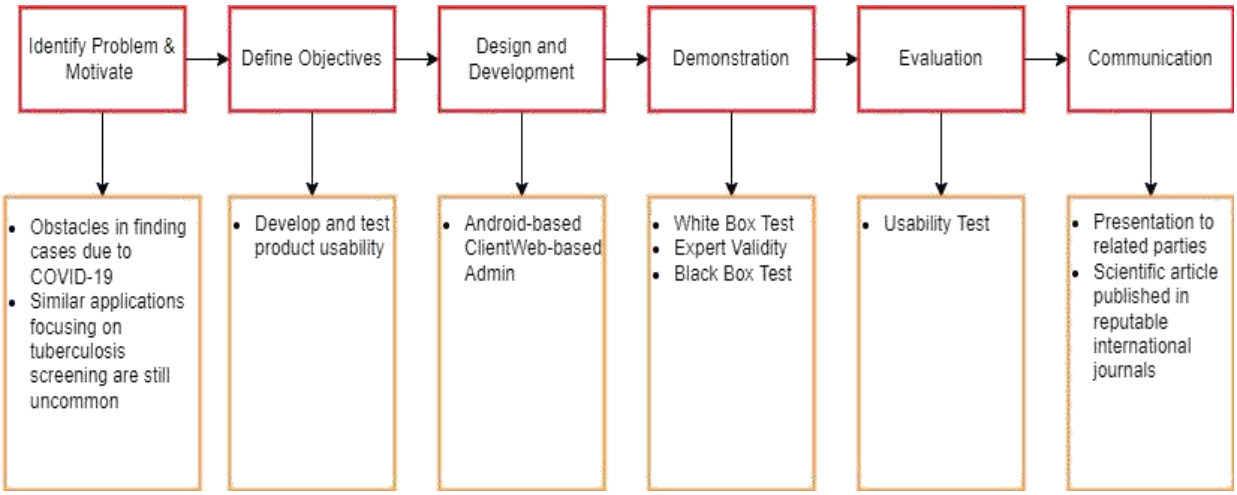

Figure 1. Design science research methodology process model for the SIKRIBO application.

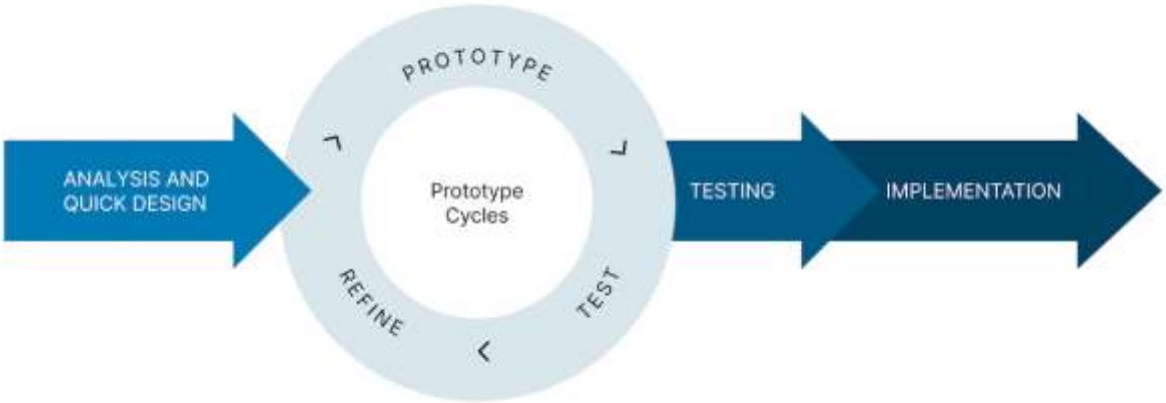

Figure 2. Stages of the rapid application development methodology.

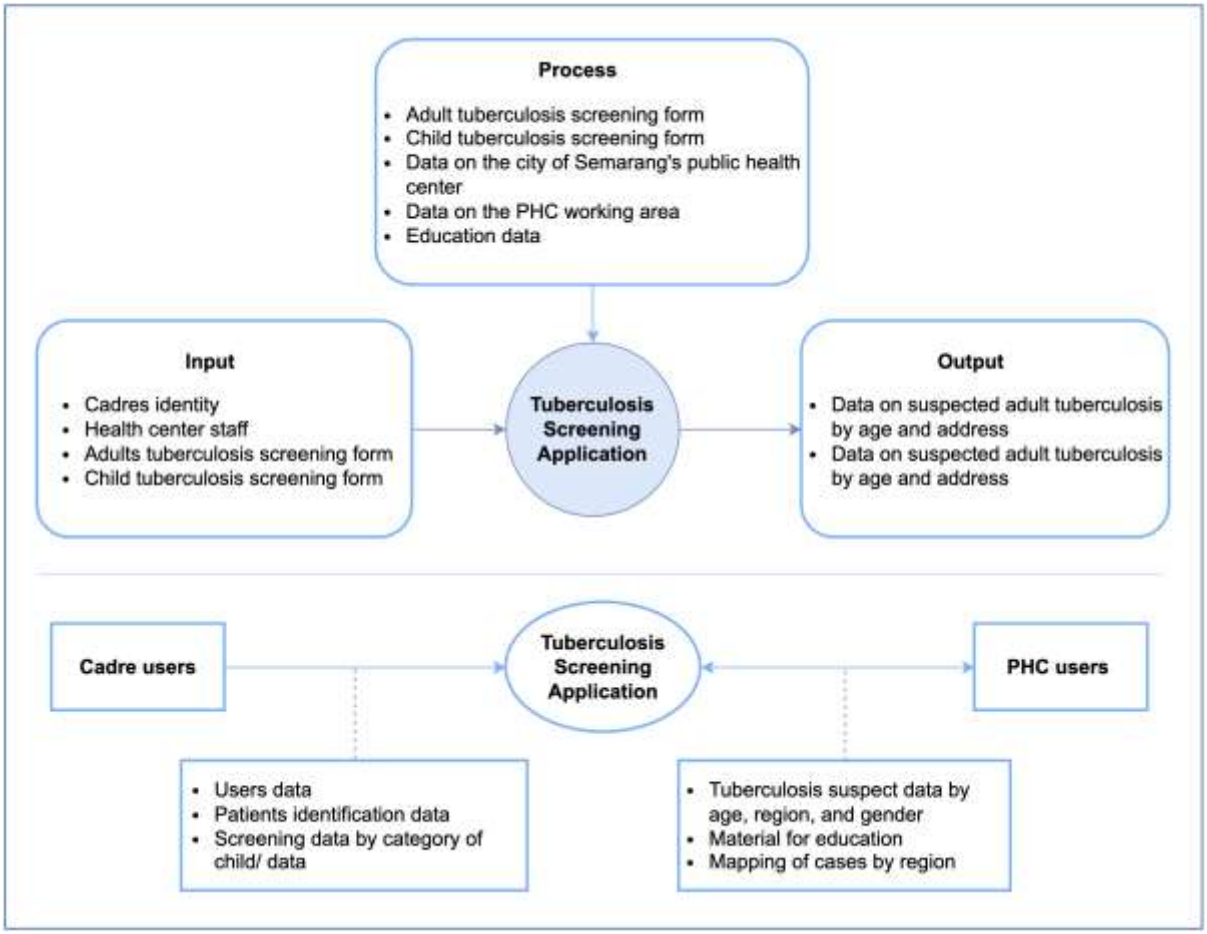

Figure 3. Data flow diagram for the SIKRIBO application. PHC, public health center.

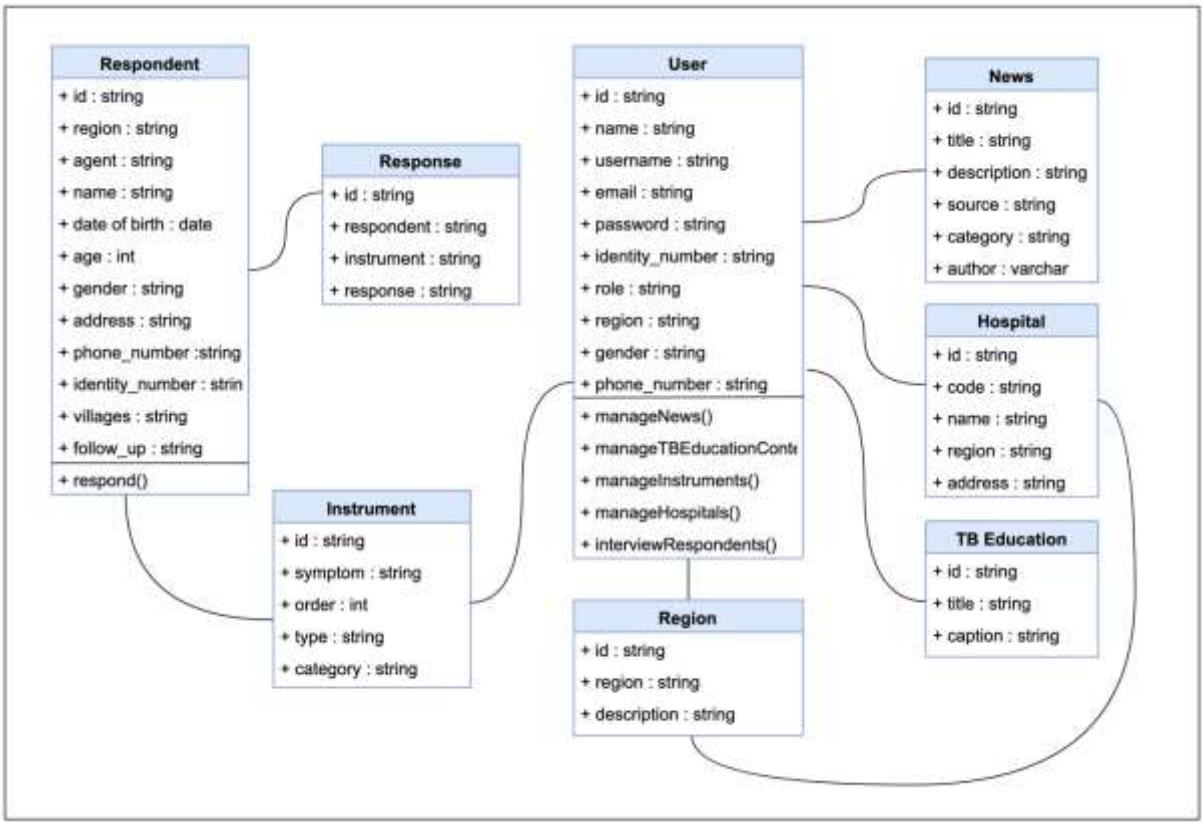

Figure 4. Class diagram for the SIKRIBO application. TB, tuberculosis.

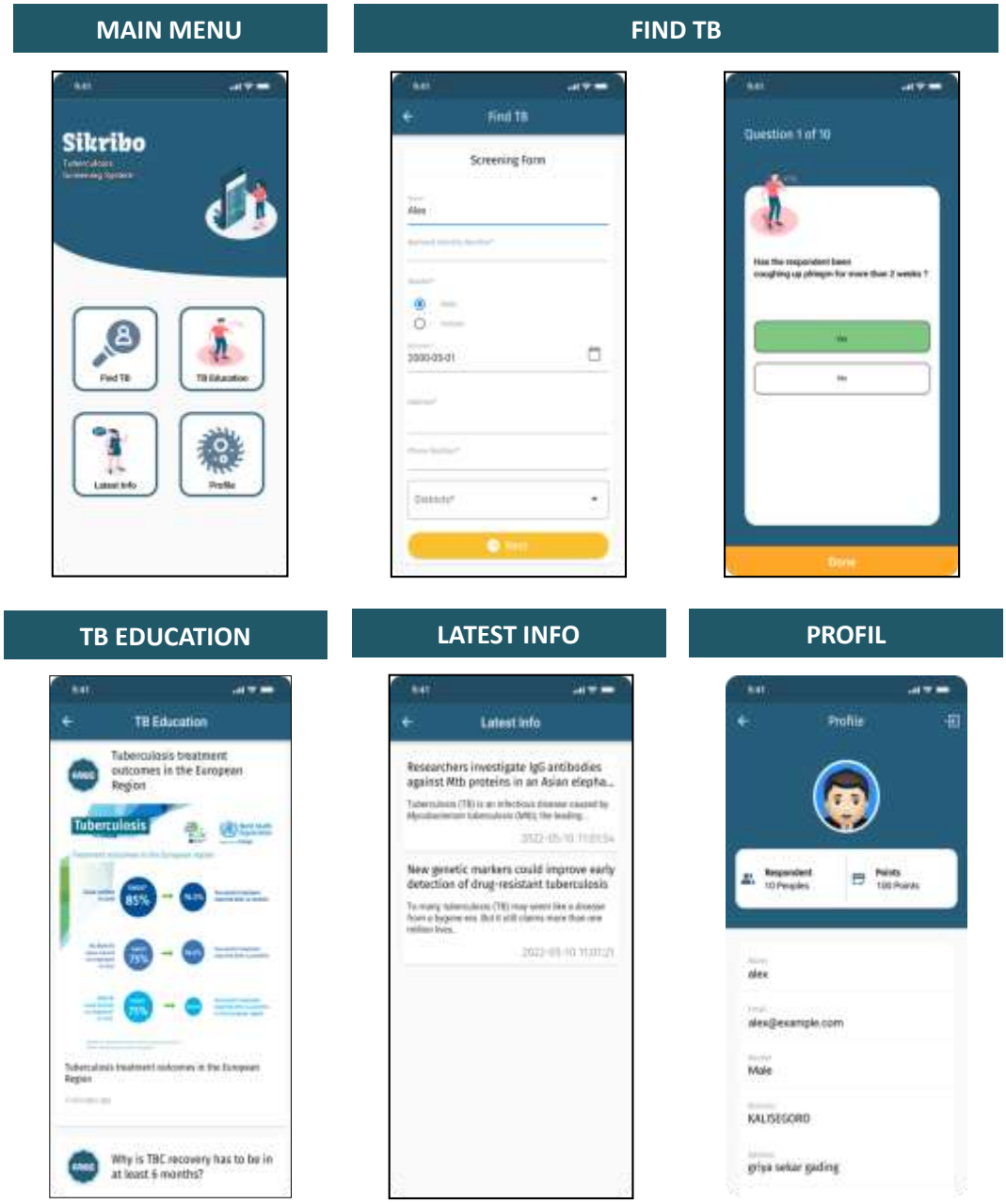

Figure 5. Display menus for the client-based Android application: Main Menu, Find TB, TB Education, Latest Info, and Profile. TB, tuberculosis.

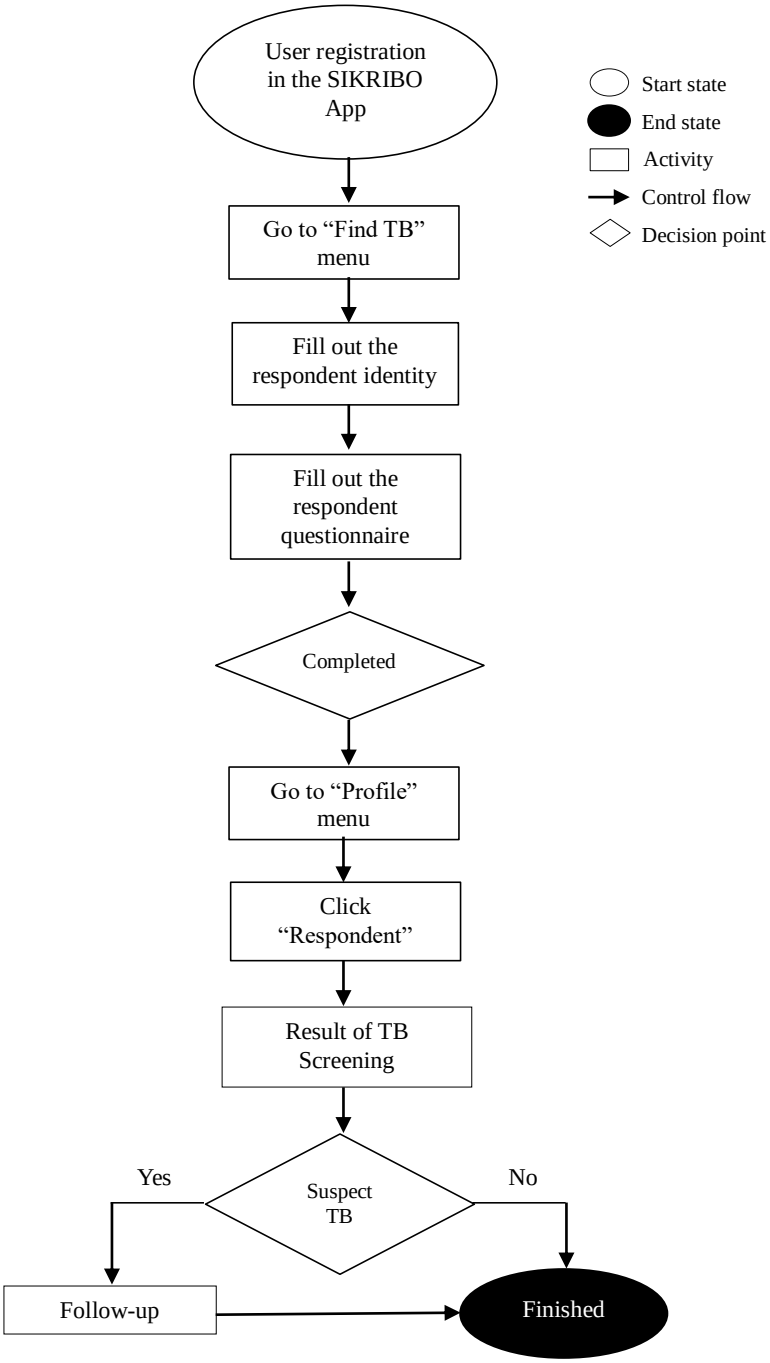

Figure 6. Flowchart of tuberculosis (TB) screening using the SIKRIBO application.

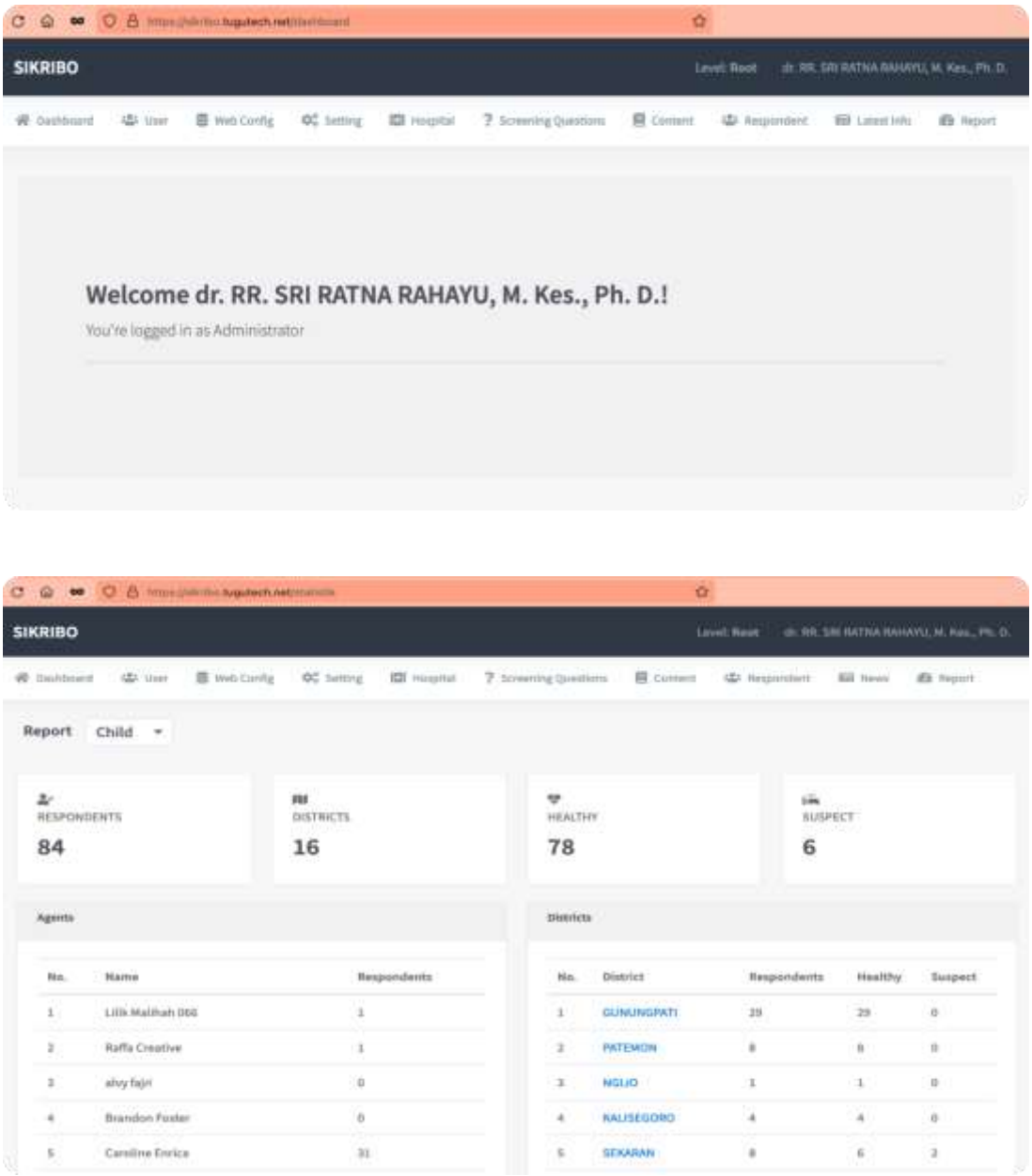

Figure 7. Web-based admin display.

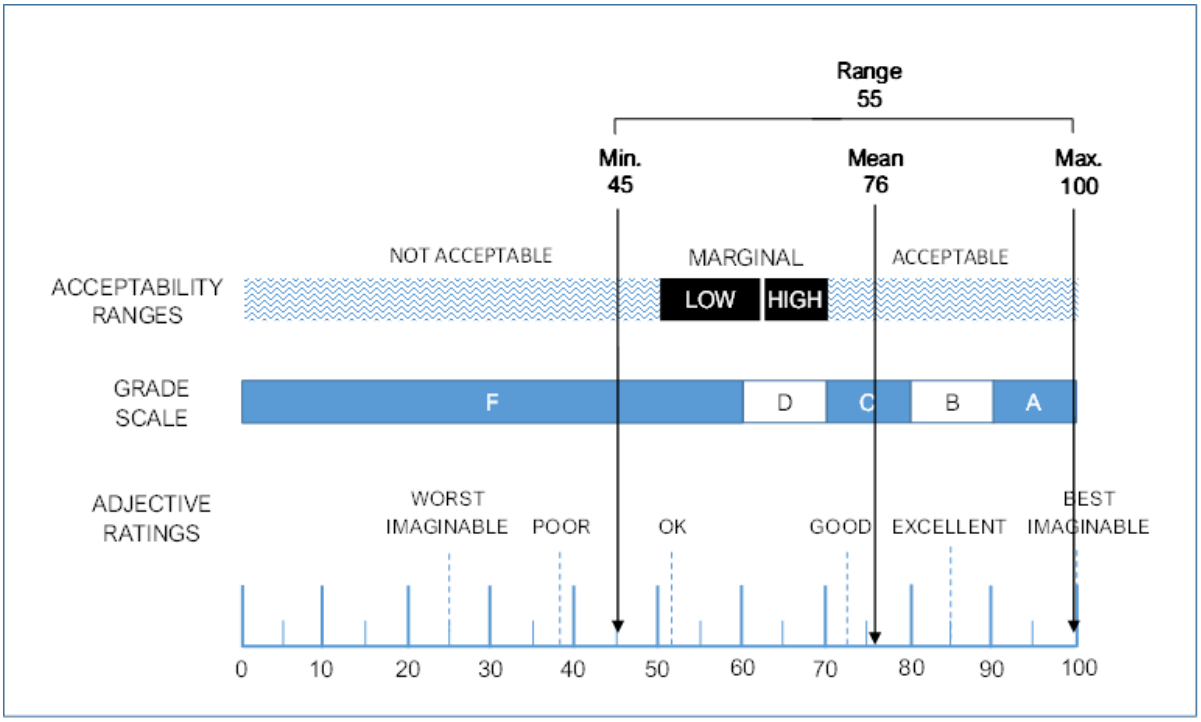

Figure 8. Overview of modified SUS rating table with study results [24][A9].

Table 1. Sociodemographic characteristics (n = 20)

Variable	n (%)
Age (yr)	
17–25	8 (40.0)
26–35	5 (25.0)
36–45	4 (20.0)
46–55	2 (10.0)
56–65	1 (5.0)
Education level	
Elementary school	1 (5.0)
Junior high school	1 (5.0)
Senior high school	4 (20.0)
College	14 (70.0)
Sex	
Male	2 (10.0)
Female	18 (90.0)

Table 2. Usability testing (n = 20)

No.	Statement	Response			Score
		Positive	Neutral	Negative	
1	I think that I would like to use this application	19 (95.0)	1 (5.0)	-	3.3 ± 0.6
2	I found application unnecessarily complex	17 (85.0)	3 (15.0)	-	3.1 ± 0.6
3	I thought application was easy to use	18 (90.0)	2 (10.0)	-	3.4 ± 0.7
4	I think that I would need the support of a technical person to be able to use application	15 (75.0)	3 (15.0)	2 (10.0)	4.0 ± 1.1
5	I found the various functions in application were well integrated	18 (90.0)	2 (10.0)	-	3.2 ± 0.6
6	I thought there was too much inconsistency in application	16 (80.0)	2 (10.0)	2 (10.0)	3.0 ± 0.9
7	I would imagine that most people would learn to use application very quickly	19 (95.0)	1 (5.0)	-	3.4 ± 0.6
8	I found application very cumbersome to use	16 (80.0)	3 (15.0)	1 (5.0)	3.1 ± 1.0
9	I felt very confident using application	18 (90.0)	2 (10.0)	-	3.4 ± 0.7
10	I needed to learn a lot of things before I could get going with application	5 (25.0)	5 (25.0)	10 (50.0)	1.7 ± 1.2
Total responses		161 (80.5)	24 (12.0)	15 (7.5)	
SUS score					76 ± 8.0

Values are presented as number (%) or mean ± standard deviation.

SUS: System Usability Scale.

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Original

Development of the SIKRIBO Mobile Health Application for Active Tuberculosis Case Detection in Semarang, Indonesia

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Running Title: SIKRIBO Mobile App for Tuberculosis

Abstract

Objectives: This study was conducted to document the development and usability testing of SIKRIBO, a tuberculosis screening application.

Methods: The SIKRIBO application was developed using design science research methodology, which has six steps: problem identification and motivation, definition of objectives for a solution, product design and development, demonstration, evaluation, and communication. A system usability scale (SUS) questionnaire was used to assess application usability. A total of 20 health cadres (trained community members) and health workers participated in the usability tests.

Results: Two versions of the application were developed: Android-based for users and web-based for administrators. The Android-based version has four main menus: Find Tuberculosis, Tuberculosis Education, Latest Info, and Profile. The web version is accessible to health workers, as well as the research team and application developers who monitor and manage the user-conducted screenings. The average SUS score was 76 (standard deviation, 8.00).

Conclusions: This application was developed to help detect active tuberculosis cases in the community. The SUS results indicate that the application is highly usable. Thus, SIKRIBO is expected to be broadly implemented to increase tuberculosis case detection through active community participation.

Keywords: Mobile Applications, Research Design, Community Participation, Tuberculosis, Internet

I. Introduction

The World Health Organization reported that in 2019, 10 million people were infected with tuberculosis (TB) and 1.2 million died [1]. The transmission rate of smear-positive tuberculosis patients is 65%, and if a single person with active TB can infect 10 to 15 people, there would be 5.8 million infections within a year [2].

Indonesia has one of the highest TB case counts in the world, and the nation accounts for 10% of the global reporting gap of tuberculosis cases due to low case detection and reporting [1].[A3][A4] As highlighted in the national TB strategy, active case-finding is the primary focus of TB control. Poor TB case detection in a community may increase that community's transmission rate [3].

Rahayu et al. [4] found that a lack of knowledge about TB symptoms and prevention contributes to delayed diagnosis. A separate longitudinal study indicated that only 52.5% of patients who began treatment were aware that cough was a symptom of TB. Those with undiagnosed TB act as reservoirs for transmission to their families [5].

The case notification rate (CNR) is an indicator of the scope of TB case detection. The Central Java TB CNR fell from 157 per 100,000 population in 2019 to 111 per 100,000 population in 2020 [6]. The TB CNR in Semarang (the capital city of Central Java Province) decreased from 258 per 100,000 population in 2019 to 155 per 100,000 population in 2020. In 2019 in Semarang, 1,653 TB cases were identified [7].

The Sekaran Public Health Center (PHC) identified 329 suspected TB cases in 2021 [7]. However prevalent the disease, community-based case-finding has not been conducted actively. One initiative of the Sekaran PHC involves the selection of individuals, termed health cadres, to empower the community in identifying TB cases. These community members can play a central role in family health and are trained for the early detection of TB symptoms in their

family members, allowing for prompt and adequate treatment.

The coronavirus disease 2019 pandemic brought numerous challenges to tuberculosis treatment efforts, particularly in case detection. Direct contact had to be avoided, especially with individuals with cough symptoms [8]. However, direct physical contact can be replaced by virtual contact to diminish the risk of exposure. Mobile health (mHealth) applications are therefore a potential solution to the challenges in TB case-finding [9].

mHealth is the application of technology in medicine and public health through mobile devices. mHealth technologies include voice and short messaging services, mobile phone applications (or apps), remote monitoring, and portable sensors. This technology can also be equipped with geographic information and global positioning systems for geographic mapping [10].

mHealth has been recognized as an affordable innovation that can bring high-quality health services to patients in low- and middle-income countries. These countries include Indonesia, due to its poor health systems, high prevalence of tropical and infectious diseases, and high mortality [11]. However, Indonesia ranks fourth in the world in the use of mobile phones, with 61.7% of the population having access to a mobile device [12].

At least 55 mHealth applications related to TB treatment are available [13]. However, only 6% of these[A5][A6] focus on TB screening, which is underrepresented in the literature [9,13]. One example, TimBre, is an Indian-based TB app designed for cough screening for the detection of pulmonary tuberculosis. Another, Si Tubo, was made in Indonesia and facilitates the early detection of tuberculosis symptoms in children [13]. The objective of this study is to present comprehensive documentation of the development and usability testing of SIKRIBO, a tuberculosis screening application.

II. Methods

The SIKRIBO application was developed using design science research methodology. This approach provides a practical framework for developing, implementing, and evaluating the designed artifact with a focus on enhancing functional performance [14]. The six activities of this methodology are explained as follows and detailed in Figure 1.

1. Identifying Problems and Motivation

Preliminary field studies were conducted to identify the challenges associated with detecting TB cases.

2. Defining Objectives of a Solution

Literature reviews were conducted to build on prior research, map the issues, and determine a solution. Additionally, studies of the evaluation and testing of various TB apps were reviewed. The goal was to document the development and usability testing of Android-based applications for the detection of active TB cases.

3. Product Design and Development

The SIKRIBO app was created using rapid application development, which produces higher-quality results much faster than other software development methodologies [15] (Figure 2).

In the first stage (analysis and quick design), a data flow diagram was created to define how the application collects and delivers data (Figure 3). The application involves interactions between agents as users, the application as a tool, and the responses of the respondents; to accommodate these interactions smoothly, the application must be well-designed. A class diagram (Figure 4) was also created to define the properties and actions of each entity using the app.

This application was developed on the Android platform using Flutter, an open-source mobile

application development framework. Android was chosen based on its 90.84% market share of Indonesian mobile phone users [15]. A backend web-based admin portal was developed using Laravel, one of the most popular PHP frameworks. After a cycle of prototyping, the application was subjected to three stages of user testing: internal trials, expert validity, and black-box testing (described in Section II-4). Finally, the app was deployed to a shared hosting environment and registered to a domain to allow public access.

4. Demonstration

This activity includes simulated running of the application via a prototype.

1) Internal trials

By analyzing the internal structure of a software program, white-box testing can uncover system implementation errors, such as poor key management. Path coverage testing was used to understand the cyclomatic complexity of the system.

2) Expert validity

Expert validity was attained through a trial of application products by media experts and public health professionals. A validation sheet questionnaire was distributed to assess and validate the application.

3) Black-box testing

Black-box testing involves observing only the fundamental aspects of the system to ensure that any specified system function or input is fully operational. In this stage, health workers of Sekaran PHC acted as administrators and users. The black-box test results showed that the application runs well and can be used reliably.

5. Evaluation (Usability Testing)[A7][A8]

Usability testing is used to determine the extent to which a product allows users to achieve specific goals. The effectiveness, efficiency, and satisfaction of using a product are considered [16].

1) Research population and design

A[A9][A10] cross-sectional design was used to evaluate the usability of the SIKRIBO app. The sample population included health cadres and health workers at Sekaran PHC in Semarang whose ages ranged from 17–65 years. The sample was designed to reflect the target users of SIKRIBO, who will be conducting TB screening for the public.

2) Sample size determination

Based on the findings of Nielsen (2006) [17], [A11][A12]20 respondents were chosen for the usability trials [18]. The sample was selected via convenience sampling, which is the most common method for usability studies [18]. Sampling was carried out at the Sekaran PHC in Semarang as a pilot health center.

3) Research instrument

The system usability scale (SUS) was chosen for the usability testing of the SIKRIBO app. This instrument is a well-validated measure of mobile application usability in questionnaire-based studies [19,20]. The SUS used in this study had been adapted into the Indonesian language, validated, and evaluated for reliability (Cronbach $\alpha = 0.841$) [16]. Additionally, a kappa analysis of the SUS instrument was conducted to measure the agreement between two raters; this yielded a fairly high kappa value ($\kappa = 0.494$), indicating moderate agreement.

The SUS consisted of 10 statement items with favorable[A13][A14] odd-numbered statements and unfavorable even-numbered statements. Responses were categorized as positive, neutral, or negative. Responses were considered positive if the respondent chose a score of 5 or 4 for odd items (favorable statements) or a score of 1 or 2 for even items (unfavorable statements), neutral if a score of 3 was selected, and negative if the respondent chose a score of 1 or 2 for odd items or a score of 5 or 4 for even items. Per Akmal Muhamat et al. [19], this system can counteract habitual bias in respondents.

For the favorable items, the individual item score was the scale position minus 1, and for the unfavorable items, the item score was 5 minus the scale position. The overall SUS score (ranging from 0 to 100) was obtained by adding the item scores and multiplying by 2.5. A product is considered to have good usability and high acceptance if the overall SUS score is 68 or higher [19].

4) Data collection

The participants were asked to install the SIKRIBO app on a smartphone by downloading it via the Google Play Store. They were told to utilize all functions of the application, including conducting TB screening independently and with other respondents. Participants were then asked to complete the SUS questionnaire.

5) Data analysis

The SUS results were calculated using Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) and analyzed using SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA) software.

6) Ethical considerations

This study was approved by the Health Research Ethics Commission of the Department of

Public Health at Semarang State University (No. 096/KEPK/EC/2021). All participants provided informed consent.

6. Communication

The final stage is communication. After evaluation, the results of product development and product evaluation are communicated to experts, target subjects, and the public. In this study, the communication stage is carried out by documenting the results of research in the form of scientific publications in reputable international journals. In addition, researchers conducted socialization of the SIKRIBO application to various primary health services in the city of Semarang and its surroundings.

III. Results

1. Product Design and Development

The tuberculosis screening application has two versions.

1) Client-based on Android

The Android version is used to collect patient screening data. It has four main menus, shown in Figure 5.

(1) Find TB

This is a form that cadres must complete when performing early screening for TB in the community. The TB screening form contains 10 questions about TB symptoms based on the World Health Organization guidelines [21]. An individual with one of these symptoms is categorized as having suspected TB. This menu includes a personal data form for the person being screened. The screening results (healthy or suspect) can be seen in the Profile

menu. Figure 6 [A15][A16]shows the steps for TB screening with this application.

(2) TB Education

This menu contains TB-related information, intended to provide the community with knowledge about the disease.

(3) Latest Info

This menu displays the latest information about TB. The information was obtained from trusted sources that are expected to provide updated information about TB to combat the spread of TB-related hoaxes in the community.

(4) Profile

When a user logs in with a Google account, the Profile menu automatically displays that user's name and email address. The goal is to provide user data to PHCs to help maintain future communication regarding TB screening follow-up.

2) Web-based Admin

The web version is accessible to health workers, as well as the research team and application developers who monitor and manage the user-conducted screenings (Figure 7).

2. Evaluation (Usability Testing)

1) Sociodemographic characteristics

Usability testing included 20 participants with the demographic characteristics presented in Table 1. The most common age range for participants was 17–25 years old (40%). The highest education level of most respondents was the tertiary level (70%), and 90% of respondents were female.

2) Usability testing

Usability testing can be used to uncover and troubleshoot any unintended actions taken by users of mobile-based applications. As shown in Table 2, almost all statements had more positive than negative responses. Statements 1 and 7 had the highest percentage of positive responses (95%). Statement 10 had the highest percentage of negative responses, at 50%. The highest average score was for the third statement, about the user-friendliness of the application, at 3.4 (standard deviation [SD], 0.68), and the lowest average score was 1.7 (SD, 1.22) for statement 10, related to self-adjustment before app use. The SUS score was 76, which exceeds the system's minimum usability score (68). The application thus has high acceptance and good usability. The usability score results are detailed in Figure 8.

IV. Discussion

Participants in the usability test displayed relatively high satisfaction with the SIKRIBO app. Most respondents indicated that they would use the application again, due to its ease of use. This finding is promising because user retention is a challenge in the development and implementation of mHealth [22]. According to Akmal Muhamat et al. [19], the ease of use of a mobile application is associated with the user's intention to use it again. The respondents also agreed that the SIKRIBO application features run properly and are well integrated. In fact, almost all respondents agreed that most people would quickly learn how to use this application. This is possible because the SIKRIBO app was developed with easily understandable features common in mobile applications, with the goal of facilitating broad user-friendliness.

However, one-half of the respondents reported that a steep learning curve was required before using the application. This aligns with the findings of Pande et al. [23], in which as many as 50% of respondents provided a similar response. This is understandable given that new technology necessitates user adaptation. One challenge in implementing mHealth is taking the

time to study the app before deploying it. Experts must be able to explain the benefits of the application to users before they are willing to adopt it into clinical practice [24].

The higher the SUS score, the more usable the system. In the present study, the mean SUS score was 76 (SD, 8.00), indicating good usability. Similarly, Idrus et al. [25] found an average SUS score of 77.7 for web-based human immunodeficiency virus and tuberculosis therapy management applications. In another study, the average mHealth SUS score was 80.5 (SD, 11.47), indicating good but not excellent usability [26].

The main purpose of the SIKRIBO app is to assist in early TB case detection in the community by utilizing digital technology. Screening through symptoms is an easy way to identify TB cases in the community. Moreover, involving the community in TB screening increases the rate of TB detection. The SIKRIBO app can help health facilities conduct TB screening in the community by involving the community as cadres. The results of these screenings are recorded in the web-based admin version of SIKRIBO to monitor cadres in screening and follow-up suspected TB cases for diagnostic examinations. Even the public can use SIKRIBO for self-screening.

mHealth can be used to help screen for infectious diseases and strengthen infectious disease surveillance across the globe. In addition, it may increase the availability of scientific research and public health initiatives [27]. Even from the perspective of health workers, as reported by Faudjar et al. [28], such digital systems are making work easier and faster, although adaptation can be slow. The SIKRIBO app is not only a screening application, but also a medium for public education about TB and its prevention, provided in the TB Education feature. Mahmood et al. [29] underscored that smartphones increase the efficiency of health education on disease and its prevention. In line with these potentially great benefits in public health, the SIKRIBO application should be released in a large initial trial for utilization by primary health facilities.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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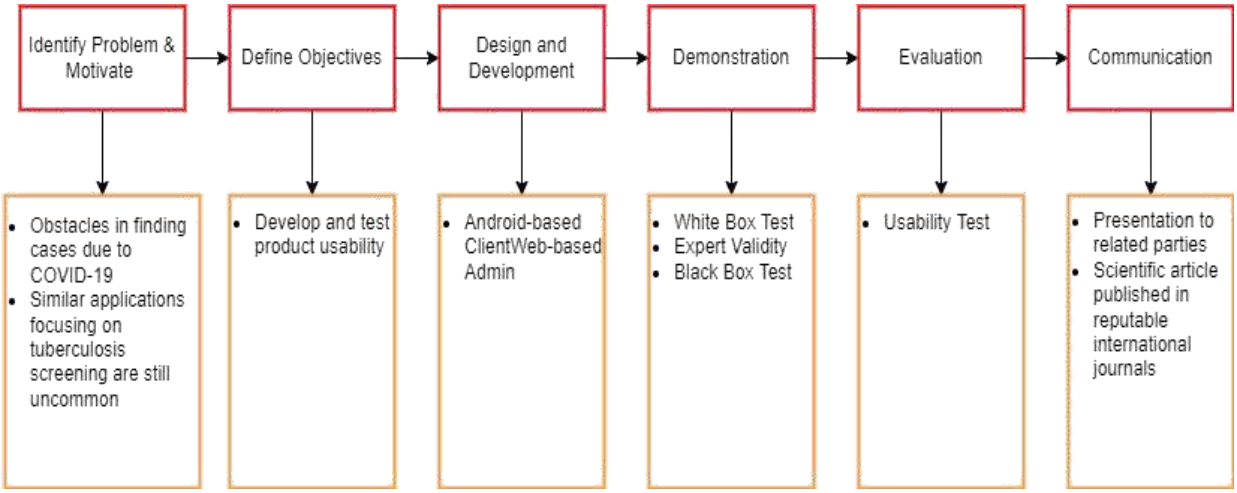

Figure 1. Design science research methodology process model for the SIKRIBO application.

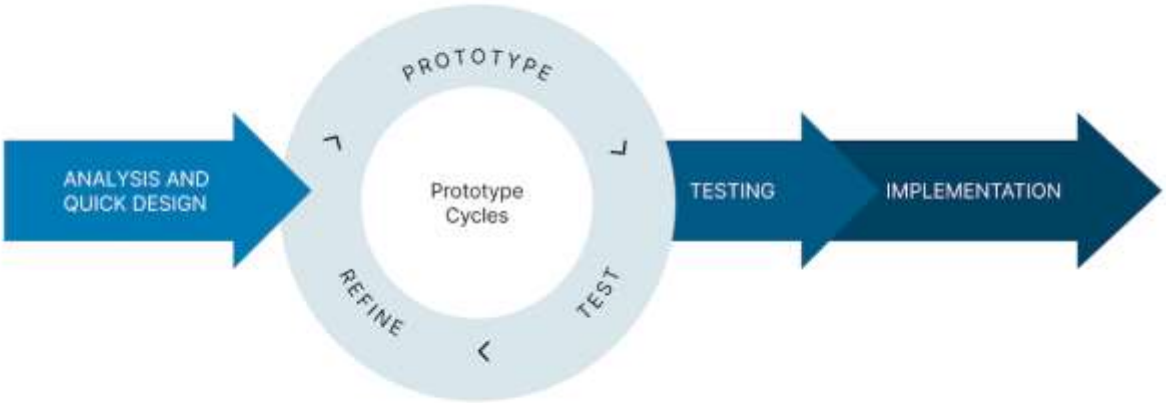

Figure 2. Stages of the rapid application development methodology.

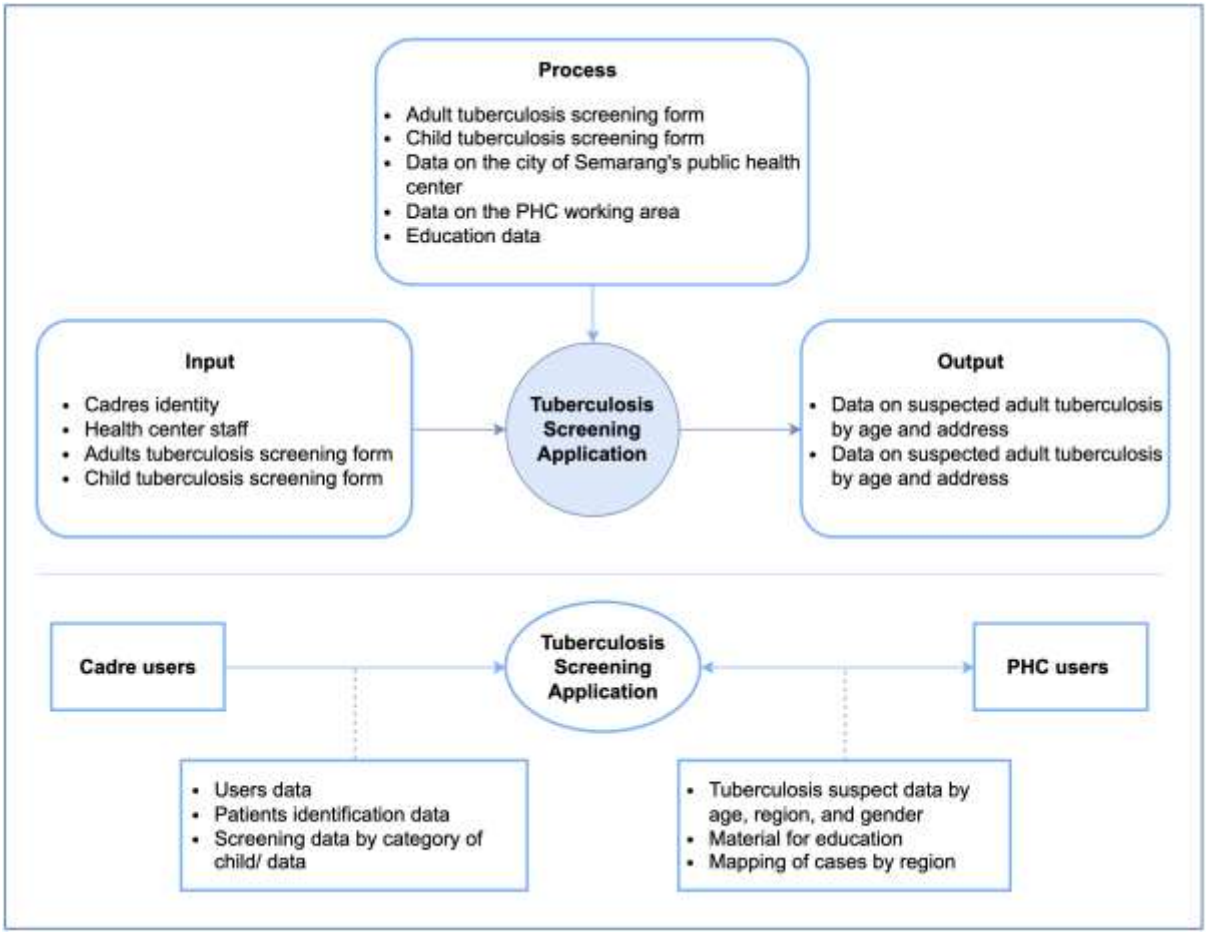

Figure 3. Data flow diagram for the SIKRIBO application. PHC, public health center.

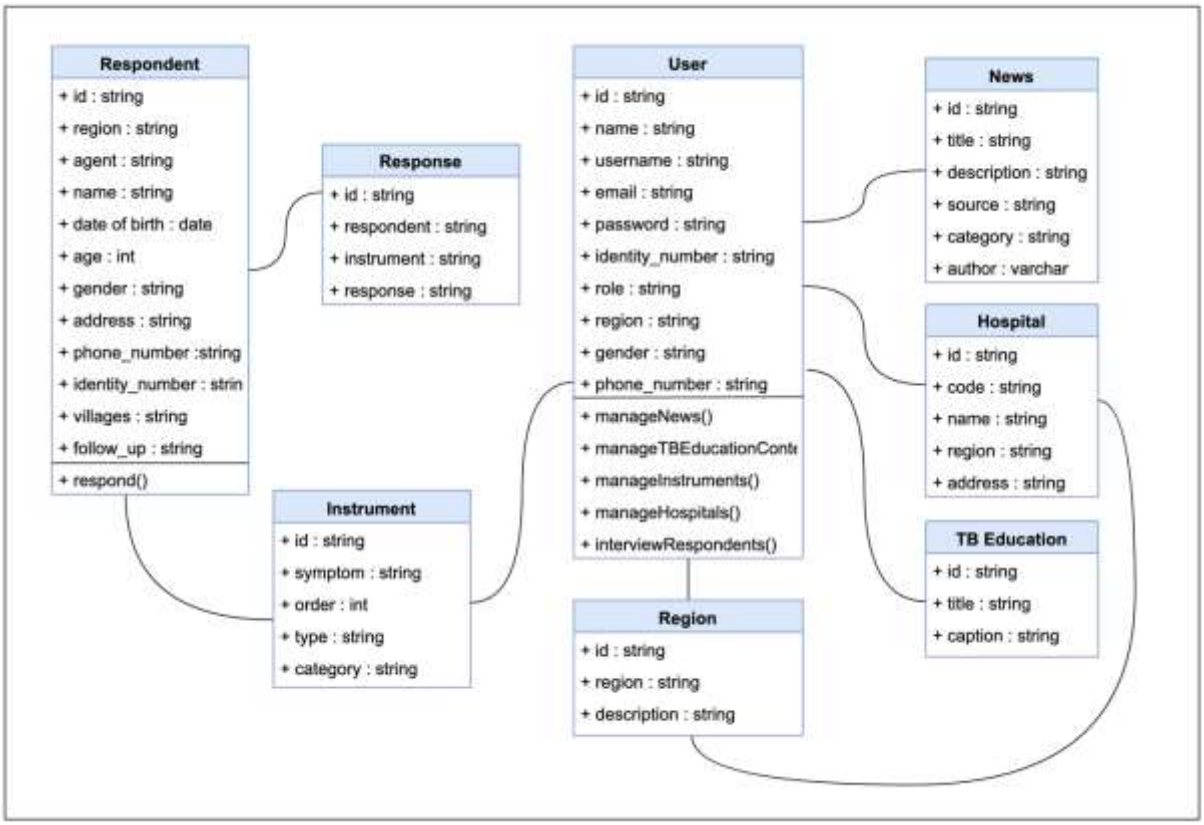

Figure 4. Class diagram for the SIKRIBO application. TB, tuberculosis.

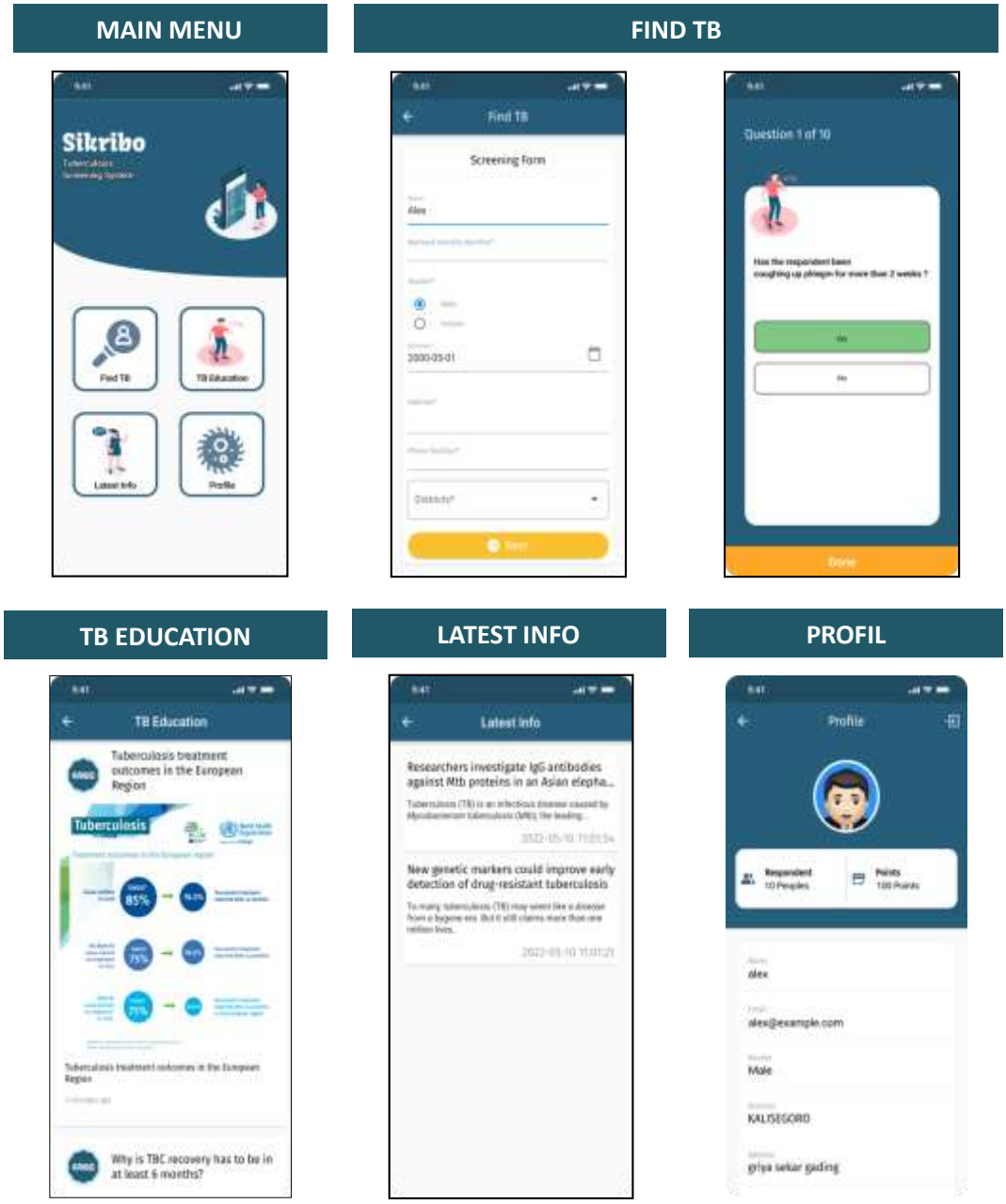

Figure 5. Display menus for the client-based Android application: Main Menu, Find TB, TB Education, Latest Info, and Profile. TB, tuberculosis.

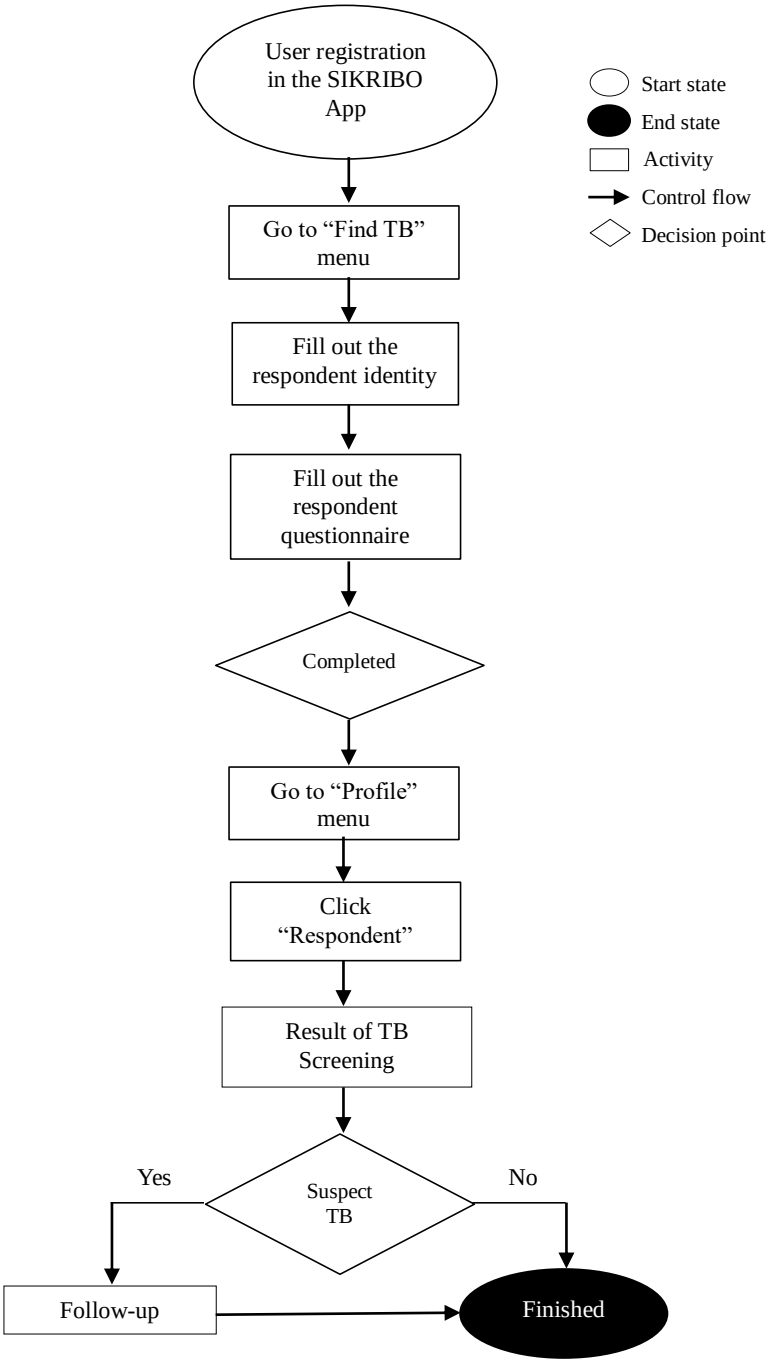

Figure 6. Flowchart of tuberculosis (TB) screening using the SIKRIBO application.

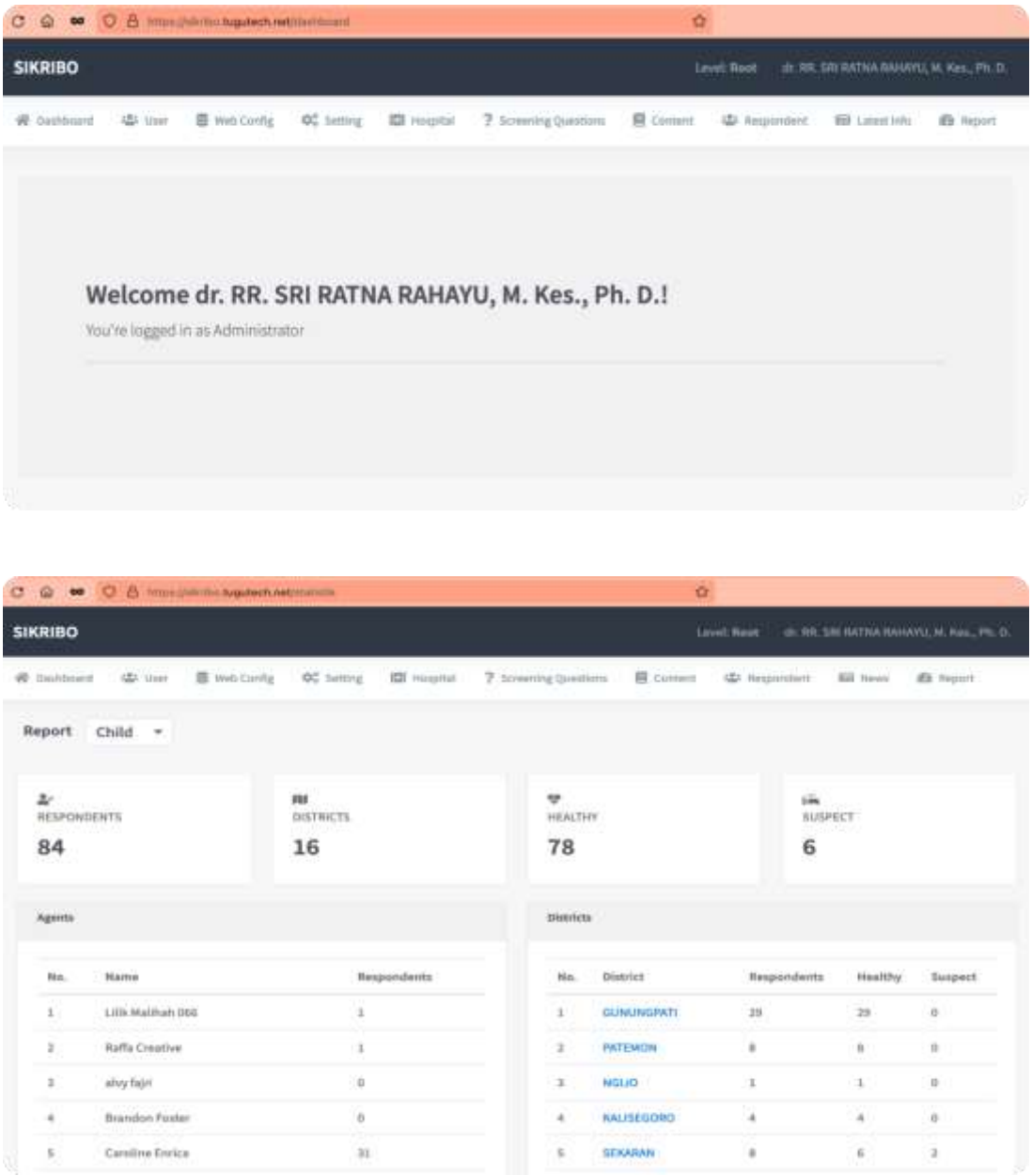

Figure 7. Web-based admin display.

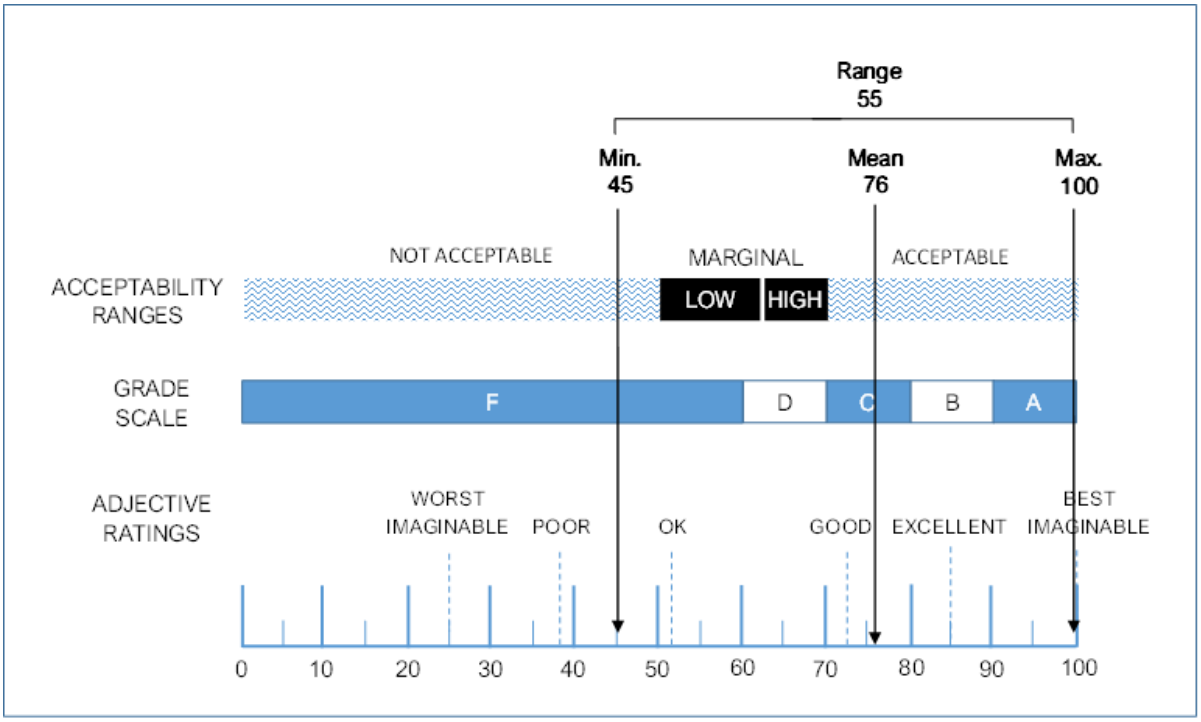

Figure 8. Overview of modified SUS rating table with study results [25][A17][A18].

Table 1. Sociodemographic characteristics (n = 20)

Variable	n (%)
Age (yr)	
17–25	8 (40.0)
26–35	5 (25.0)
36–45	4 (20.0)
46–55	2 (10.0)
56–65	1 (5.0)
Education level	
Elementary school	1 (5.0)
Junior high school	1 (5.0)
Senior high school	4 (20.0)
College	14 (70.0)
Sex	
Male	2 (10.0)
Female	18 (90.0)

Table 2. Usability testing (n = 20)

No.	Statement	Response			Score
		Positive	Neutral	Negative	
1	I think that I would like to use this application	19 (95.0)	1 (5.0)	-	3.3 ± 0.6
2	I found application unnecessarily complex	17 (85.0)	3 (15.0)	-	3.1 ± 0.6
3	I thought application was easy to use	18 (90.0)	2 (10.0)	-	3.4 ± 0.7
4	I think that I would need the support of a technical person to be able to use application	15 (75.0)	3 (15.0)	2 (10.0)	4.0 ± 1.1
5	I found the various functions in application were well integrated	18 (90.0)	2 (10.0)	-	3.2 ± 0.6
6	I thought there was too much inconsistency in application	16 (80.0)	2 (10.0)	2 (10.0)	3.0 ± 0.9
7	I would imagine that most people would learn to use application very quickly	19 (95.0)	1 (5.0)	-	3.4 ± 0.6
8	I found application very cumbersome to use	16 (80.0)	3 (15.0)	1 (5.0)	3.1 ± 1.0
9	I felt very confident using application	18 (90.0)	2 (10.0)	-	3.4 ± 0.7
10	I needed to learn a lot of things before I could get going with application	5 (25.0)	5 (25.0)	10 (50.0)	1.7 ± 1.2
Total responses		161 (80.5)	24 (12.0)	15 (7.5)	
SUS score					76 ± 8.0

Values are presented as number (%) or mean ± standard deviation.

SUS: System Usability Scale.

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Development of the SIKRIBO Mobile Health Application for Active Tuberculosis Case Detection in Semarang, Indonesia

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Objectives: This study was conducted to document the development and usability testing of SIKRIBO, a tuberculosis screening application. **Methods:** The SIKRIBO application was developed using design science research methodology, which has six steps: problem identification and motivation, definition of objectives for a solution, product design and development, demonstration, evaluation, and communication. A system usability scale (SUS) questionnaire was used to assess application usability. A total of 20 health cadres (trained community members) and health workers participated in the usability tests. **Results:** Two versions of the application were developed: Android-based for users and web-based for administrators. The Android-based version has four main menus: Find Tuberculosis, Tuberculosis Education, Latest Info, and Profile. The web version is accessible to health workers, as well as the research team and application developers who monitor and manage the user-conducted screenings. The average SUS score was 76 (standard deviation, 8.00). **Conclusions:** This application was developed to help detect active tuberculosis cases in the community. The SUS results indicate that the application is highly usable. Thus, SIKRIBO is expected to be broadly implemented to increase tuberculosis case detection through active community participation.

Keywords: Mobile Applications, Research Design, Community Participation, Tuberculosis, Internet

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I. Introduction

The World Health Organization reported that in 2019, 10 million people were infected with tuberculosis (TB) and 1.2 million died [1]. The transmission rate of smear-positive tuberculosis patients is 65%, and if a single person with active TB can infect 10 to 15 people, there would be 5.8 million infections within a year [2].

Indonesia has one of the highest TB case counts in the world, and the nation accounts for 10% of the global reporting gap of tuberculosis cases due to low case detection and reporting [1]. As highlighted in the national TB strategy,

active case-finding is the primary focus of TB control. Poor TB case detection in a community may increase that community's transmission rate [3].

Rahayu et al. [4] found that a lack of knowledge about TB symptoms and prevention contributes to delayed diagnosis. A separate longitudinal study indicated that only 52.5% of patients who began treatment were aware that cough was a symptom of TB. Those with undiagnosed TB act as reservoirs for transmission to their families [5].

The case notification rate (CNR) is an indicator of the scope of TB case detection. The Central Java TB CNR fell from 157 per 100,000 population in 2019 to 111 per 100,000 population in 2020 [6]. The TB CNR in Semarang (the capital city of Central Java Province) decreased from 258 per 100,000 population in 2019 to 155 per 100,000 population in 2020. In 2019 in Semarang, 1,653 TB cases were identified [7].

The Sekaran Public Health Center (PHC) identified 329 suspected TB cases in 2021 [7]. However prevalent the disease, community-based case-finding has not been conducted actively. One initiative of the Sekaran PHC involves the selection of individuals, termed health cadres, to empower the community in identifying TB cases. These community members can play a central role in family health and are trained for the early detection of TB symptoms in their family members, allowing for prompt and adequate treatment.

The coronavirus disease 2019 pandemic brought numerous challenges to tuberculosis treatment efforts, particularly in case detection. Direct contact had to be avoided, especially with individuals with cough symptoms [8]. However, direct physical contact can be replaced by virtual contact to diminish the risk of exposure. Mobile health (mHealth) applications are therefore a potential solution to the challenges in TB case-finding [9].

mHealth is the application of technology in medicine and public health through mobile devices. mHealth technologies include voice and short messaging services, mobile phone applications (or apps), remote monitoring, and portable sensors. This technology can also be equipped with geographic information and global positioning systems for geographic mapping [10].

mHealth has been recognized as an affordable innovation that can bring high-quality health services to patients in low- and middle-income countries. These countries include Indonesia, due to its poor health systems, high prevalence of tropical and infectious diseases, and high mortality [11]. However, Indonesia ranks fourth in the world in the use of mobile phones, with 61.7% of the population having access to a mobile device [12].

At least 55 mHealth applications related to TB treatment are available [13]. However, only 6% of the 55 mHealth apps focus on TB screening, which is underrepresented in the literature [9,13]. One example, TimBre, is an Indian-based TB app designed for cough screening for the detection of pulmonary tuberculosis. Another, Si Tubo, was made in Indonesia and facilitates the early detection of tuberculosis symptoms in children [13]. The objective of this study is to present comprehensive documentation of the development and usability testing of SIKRIBO, a tuberculosis screening application.

II. Methods

The SIKRIBO application was developed using design science research methodology. This approach provides a practical framework for developing, implementing, and evaluating the designed artifact with a focus on enhancing functional performance [14]. The six activities of this methodology are explained as follows and detailed in Figure 1.

1. Identifying Problems and Motivation

Preliminary field studies were conducted to identify the challenges associated with detecting TB cases.

2. Defining Objectives of a Solution

Literature reviews were conducted to build on prior re-

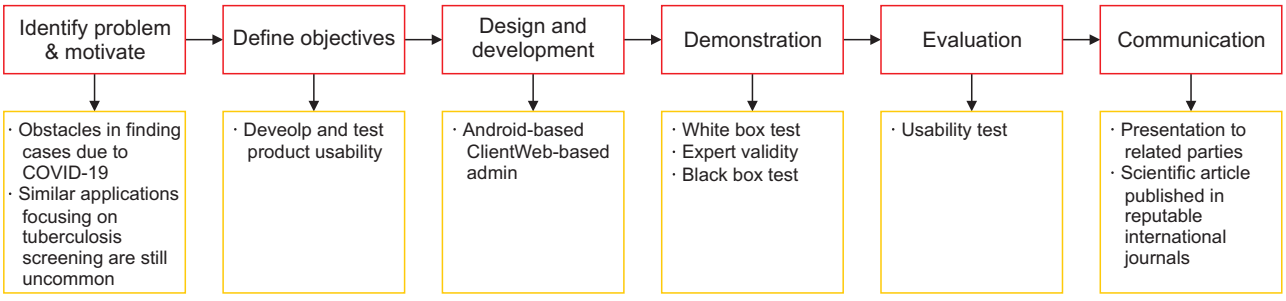

Figure 1. Design science research methodology process model for the SIKRIBO application.

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search, map the issues, and determine a solution. Additionally, studies of the evaluation and testing of various TB apps were reviewed. The goal was to document the development and usability testing of Android-based applications for the detection of active TB cases.

3. Product Design and Development

The SIKRIBO app was created using rapid application development, which produces higher-quality results much faster than other software development methodologies [15] (Figure 2).

In the first stage (analysis and quick design), a data flow diagram was created to define how the application collects and delivers data (Figure 3). The application involves interactions between agents as users, the application as a tool, and the responses of the respondents; to accommodate these interactions smoothly, the application must be well-designed. A class diagram (Figure 4) was also created to define the properties and actions of each entity using the app.

This application was developed on the Android platform using Flutter, an open-source mobile application development framework. Android was chosen based on its 90.84% market share of Indonesian mobile phone users [15]. A backend web-based admin portal was developed using Laravel, one of the most popular PHP frameworks. After a cycle of prototyping, the application was subjected to three stages of user testing: internal trials, expert validity, and black-box testing (described in Section II-4). Finally, the app was deployed to a shared hosting environment and registered to a domain to allow public access.

4. Demonstration

This activity includes simulated running of the application via a prototype.

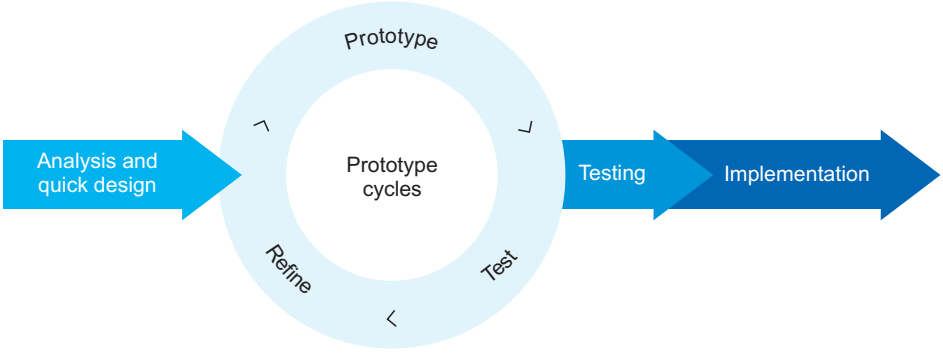

Figure 2. Stages of the rapid application development methodology.

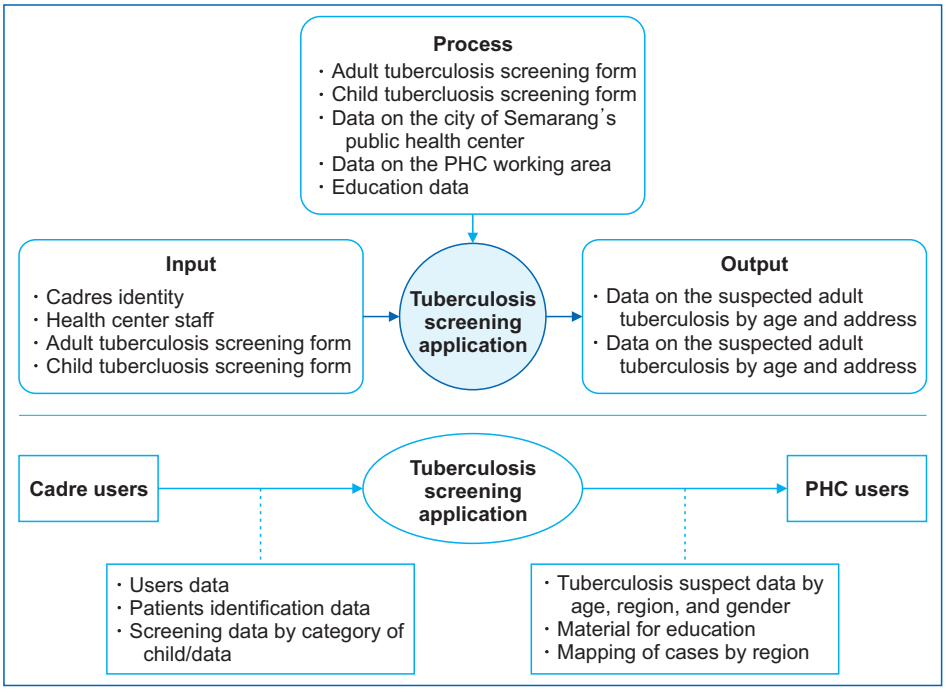

Figure 3. Data flow diagram for the SIKRIBO application. PHC: public health center.

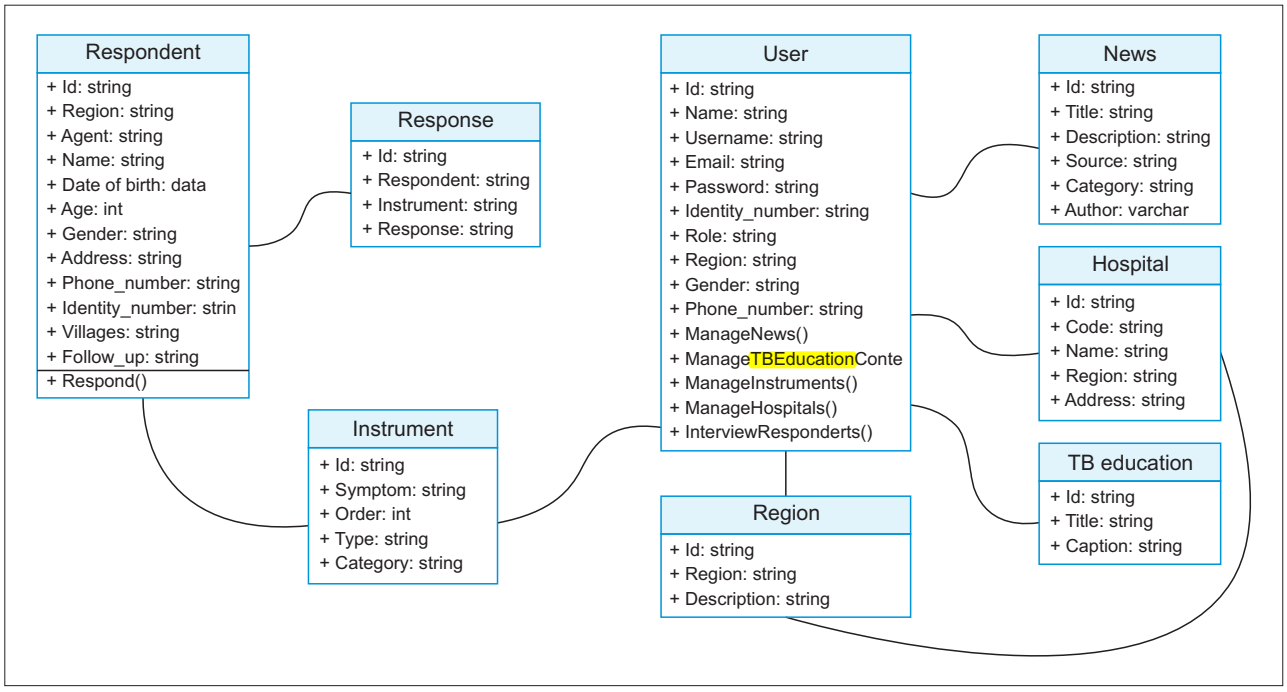

Figure 4. Class diagram for the SIKRIBO application. TB: tuberculosis.

1) Internal trials

By analyzing the internal structure of a software program, white-box testing can uncover system implementation errors, such as poor key management. Path coverage testing was used to understand the cyclomatic complexity of the system.

2) Expert validity

Expert validity was attained through a trial of application products by media experts and public health professionals. A validation sheet questionnaire was distributed to assess and validate the application.

3) Black-box testing

Black-box testing involves observing only the fundamental aspects of the system to ensure that any specified system function or input is fully operational. In this stage, health workers of Sekaran PHC acted as administrators and users. The black-box test results showed that the application runs well and can be used reliably.

5. Evaluation (Usability Testing)

Usability testing is used to determine the extent to which a product allows users to achieve specific goals. The effectiveness, efficiency, and satisfaction of using a product are considered [16].

1) Research population and design

A cross-sectional design was used to evaluate the usability of the SIKRIBO app. The sample population included health cadres and health workers at Sekaran PHC in Semarang whose ages ranged from 17–65 years. The sample was designed to reflect the target users of SIKRIBO, who will be conducting TB screening for the public.

2) Sample size determination

Based on the findings of Nielsen [17], 20 respondents were chosen for the usability trials [18]. The sample was selected via convenience sampling, which is the most common method for usability studies [18]. Sampling was carried out at the Sekaran PHC in Semarang as a pilot health center.

3) Research instrument

The system usability scale (SUS) was chosen for the usability testing of the SIKRIBO app. This instrument is a well-validated measure of mobile application usability in questionnaire-based studies [19,20]. The SUS used in this study had been adapted into the Indonesian language, validated, and evaluated for reliability (Cronbach α = 0.841) [16]. Additionally, a kappa analysis of the SUS instrument was conducted to measure the agreement between two raters; this yielded a fairly high kappa value (κ = 0.494), indicating moderate agreement.

The SUS consisted of 10 statement items with favorable

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odd-numbered statements and unfavorable even-numbered statements. Responses were categorized as positive, neutral, or negative. Responses were considered positive if the respondent chose a score of 5 or 4 for odd items (favorable statements) or a score of 1 or 2 for even items (unfavorable statements), neutral if a score of 3 was selected, and negative if the respondent chose a score of 1 or 2 for odd items or a score of 5 or 4 for even items. Per Akmal Muhamat et al. [19], this system can counteract habitual bias in respondents.

For the favorable items, the individual item score was the scale position minus 1, and for the unfavorable items, the item score was 5 minus the scale position. The overall SUS score (ranging from 0 to 100) was obtained by adding the item scores and multiplying by 2.5. A product is considered to have good usability and high acceptance if the overall SUS score is 68 or higher [19].

4) Data collection

The participants were asked to install the SIKRIBO app on a smartphone by downloading it via the Google Play Store. They were told to utilize all functions of the application, including conducting TB screening independently and with other respondents. Participants were then asked to complete the SUS questionnaire.

5) Data analysis

The SUS results were calculated using Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) and analyzed using SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA) software.

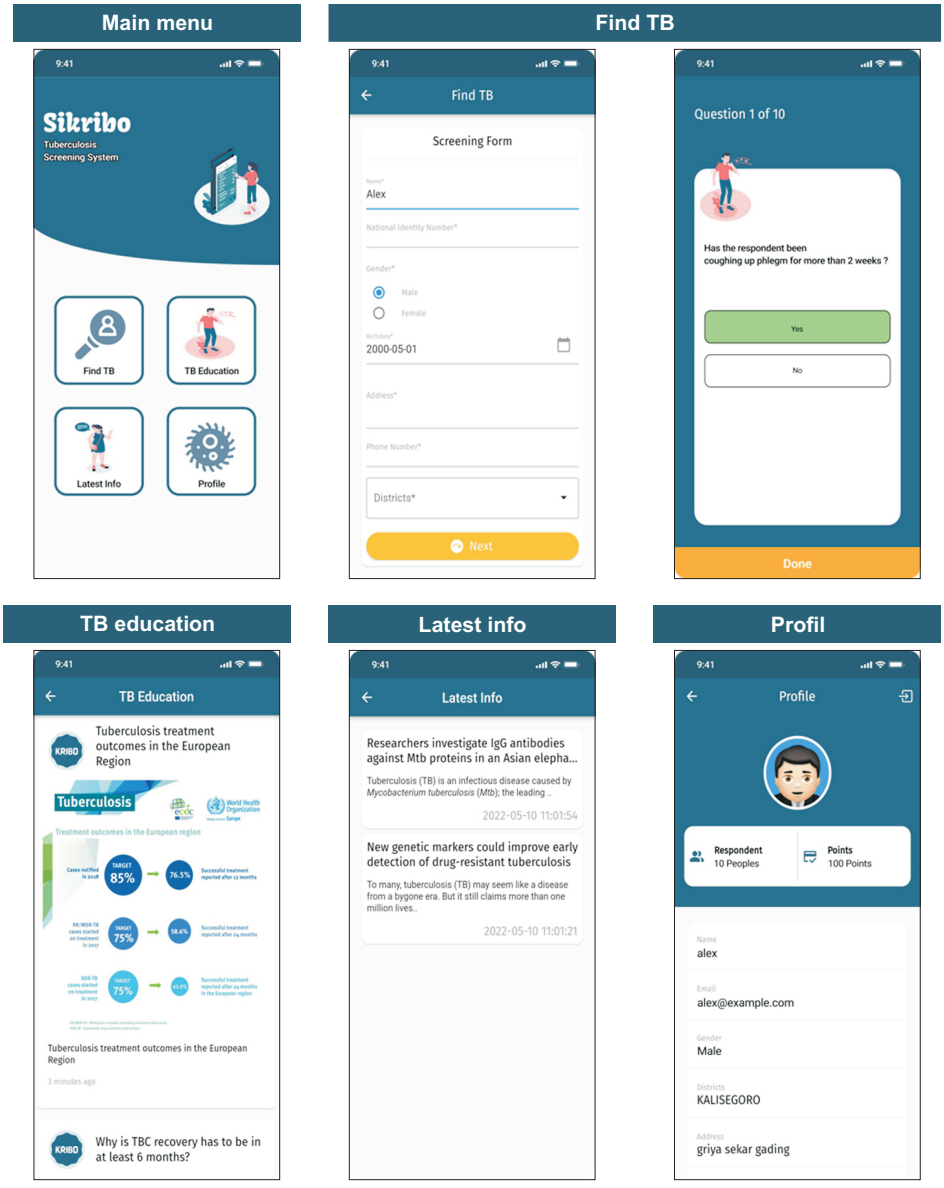

Figure 5. Display menus for the client-based Android application: Main Menu, Find TB, TB Education, Latest Info, and Profile. TB: tuberculosis.

6) Ethical considerations

This study was approved by the Health Research Ethics Commission of the Department of Public Health at Semarang State University (No. 096/KEPK/EC/2021). All participants provided informed consent.

6. Communication

The final stage is communication. After evaluation, the results of product development and product evaluation are communicated to experts, target subjects, and the public. In this study, the communication stage is carried out by documenting the results of research in the form of scientific publications in reputable international journals. In addition, researchers conducted socialization of the SIKRIBO application to various primary health services in the city of Semarang and its surroundings.

III. Results

1. Product Design and Development

The tuberculosis screening application has two versions.

1) Client-based on Android

The Android version is used to collect patient screening data. It has four main menus, shown in Figure 5.

(1) Find TB

This is a form that cadres must complete when performing early screening for TB in the community. The TB screening form contains 10 questions about TB symptoms based on the World Health Organization guidelines [21]. An individual with one of these symptoms is categorized as having suspected TB. This menu includes a personal data form for the person being screened. The screening results (healthy or suspect) can be seen in the Profile menu. Figure 6 shows the steps for TB screening with this application.

(2) TB Education

This menu contains TB-related information, intended to provide the community with knowledge about the disease.

(3) Latest Info

This menu displays the latest information about TB. The information was obtained from trusted sources that are expected to provide updated information about TB to combat the spread of TB-related hoaxes in the community.

(4) Profile

When a user logs in with a Google account, the profile menu automatically displays that user's name and email address. The goal is to provide user data to PHCs to help maintain future communication regarding TB screening follow-up.

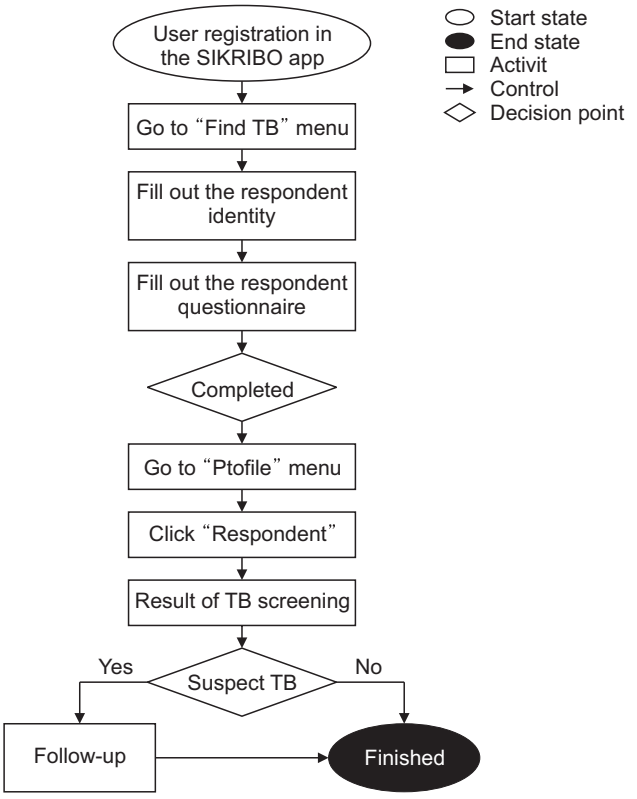

Figure 6. Flowchart of tuberculosis (TB) screening using the SIKRIBO application.

2) Web-based Admin

The web version is accessible to health workers, as well as the research team and application developers who monitor and manage the user-conducted screenings (Figure 7).

2. Evaluation (Usability Testing)

1) Sociodemographic characteristics

Usability testing included 20 participants with the demographic characteristics presented in Table 1. The most common age range for participants was 17–25 years old (40%). The highest education level of most respondents was the tertiary level (70%), and 90% of respondents were female.

2) Usability testing

Usability testing can be used to uncover and troubleshoot any unintended actions taken by users of mobile-based applications. As shown in Table 2, almost all statements had more positive than negative responses. Statements 1 and 7 had the highest percentage of positive responses (95%). Statement 10 had the highest percentage of negative responses, at 50%. The highest average score was for the third statement, about the user-friendliness of the application, at 3.4 (standard deviation [SD], 0.68), and the lowest aver-

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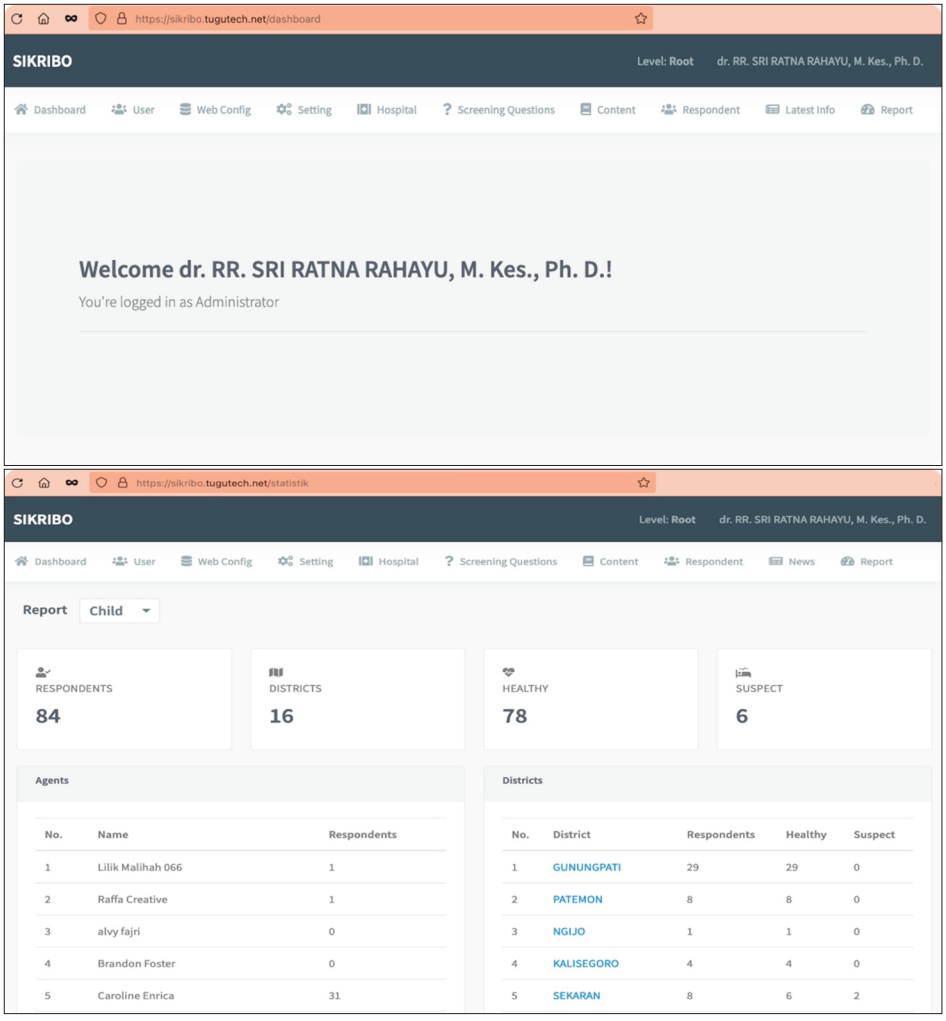

Figure 7. Web-based admin display.

Table 1. Sociodemographic characteristics (n = 20)

Variable	n (%)
Age (yr)	
17–25	8 (40.0)
26–35	5 (25.0)
36–45	4 (20.0)
46–55	2 (10.0)
56–65	1 (5.0)
Education level	
Elementary school	1 (5.0)
Junior high school	1 (5.0)
Senior high school	4 (20.0)
College	14 (70.0)
Sex	
Male	2 (10.0)
Female	18 (90.0)

age score was 1.7 (SD, 1.22) for statement 10, related to self-adjustment before app use. The SUS score was 76, which exceeds the system's minimum usability score (68). The application thus has high acceptance and good usability. The usability score results are detailed in Figure 8.

IV. Discussion

Participants in the usability test displayed relatively high satisfaction with the SIKRIBO app. Most respondents indicated that they would use the application again, due to its ease of use. This finding is promising because user retention is a challenge in the development and implementation of mHealth [22]. According to Akmal Muhamat et al. [19], the ease of use of a mobile application is associated with the user's intention to use it again. The respondents also agreed that the SIKRIBO application features run properly and are well integrated. In fact, almost all respondents agreed that most people would quickly learn how to use this application. This is possible because the SIKRIBO app was developed

Table 2. Usability testing (n = 20)

No.	Statement	Response			Score
		Positive	Neutral	Negative	
1	I think that I would like to use this application	19 (95.0)	1 (5.0)	-	3.3 ± 0.6
2	I found application unnecessarily complex	17 (85.0)	3 (15.0)	-	3.1 ± 0.6
3	I thought application was easy to use	18 (90.0)	2 (10.0)	-	3.4 ± 0.7
4	I think that I would need the support of a technical person to be able to use application	15 (75.0)	3 (15.0)	2 (10.0)	4.0 ± 1.1
5	I found the various functions in application were well integrated	18 (90.0)	2 (10.0)	-	3.2 ± 0.6
6	I thought there was too much inconsistency in application	16 (80.0)	2 (10.0)	2 (10.0)	3.0 ± 0.9
7	I would imagine that most people would learn to use application very quickly	19 (95.0)	1 (5.0)	-	3.4 ± 0.6
8	I found application very cumbersome to use	16 (80.0)	3 (15.0)	1 (5.0)	3.1 ± 1.0
9	I felt very confident using application	18 (90.0)	2 (10.0)	-	3.4 ± 0.7
10	I needed to learn a lot of things before I could get going with application	5 (25.0)	5 (25.0)	10 (50.0)	1.7 ± 1.2
Total responses		161 (80.5)	24 (12.0)	15 (7.5)	
SUS score					76 ± 8.0

Values are presented as number (%) or mean ± standard deviation.
SUS: System Usability Scale.

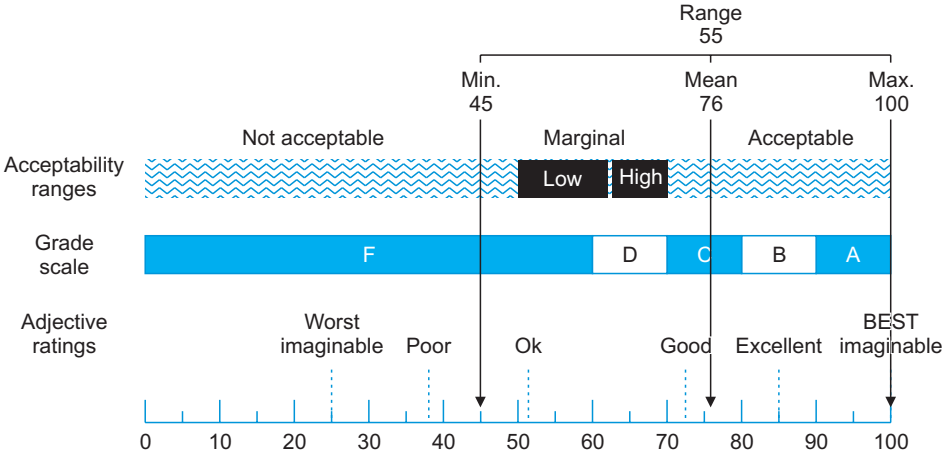

Figure 8. Overview of modified SUS rating table with study results. Adapted from [25].

with easily understandable features common in mobile applications, with the goal of facilitating broad user-friendliness.

However, one-half of the respondents reported that a steep learning curve was required before using the application. This aligns with the findings of Pande et al. [23], in which as many as 50% of respondents provided a similar response. This is understandable given that new technology necessitates user adaptation. One challenge in implementing mHealth is taking the time to study the app before deploying it. Experts must be able to explain the benefits of the application to users before they are willing to adopt it into clinical practice [24].

The higher the SUS score, the more usable the system. In the present study, the mean SUS score was 76 (SD, 8.00), indicating good usability. Similarly, Idrus et al. [25] found an average SUS score of 77.7 for web-based human immunodeficiency virus and tuberculosis therapy management applications. In another study, the average mHealth SUS score was 80.5 (SD, 11.47), indicating good but not excellent usability [26].

The main purpose of the SIKRIBO app is to assist in early TB case detection in the community by utilizing digital technology. Screening through symptoms is an easy way to identify TB cases in the community. Moreover, involving the community in TB screening increases the rate of TB detection. The SIKRIBO app can help health facilities conduct TB screening in the community by involving the community as cadres. The results of these screenings are recorded in the

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web-based admin version of SIKRIBO to monitor cadres in screening and follow-up suspected TB cases for diagnostic examinations. Even the public can use SIKRIBO for self-screening.

mHealth can be used to help screen for infectious diseases and strengthen infectious disease surveillance across the globe. In addition, it may increase the availability of scientific research and public health initiatives [27]. Even from the perspective of health workers, as reported by Faujdar et al. [28], such digital systems are making work easier and faster, although adaptation can be slow. The SIKRIBO app is not only a screening application, but also a medium for public education about TB and its prevention, provided in the TB Education feature. Mahmood et al. [29] underscored that smartphones increase the efficiency of health education on disease and its prevention. In line with these potentially great benefits in public health, the SIKRIBO application should be released in a large initial trial for utilization by primary health facilities.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Acknowledgments

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Development of the SIKRIBO Mobile Health Application for Active Tuberculosis Case Detection in Semarang, Indonesia

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Objectives: This study was conducted to document the development and usability testing of SIKRIBO, a tuberculosis screening application. **Methods:** The SIKRIBO application was developed using design science research methodology, which has six steps: problem identification and motivation, definition of objectives for a solution, product design and development, demonstration, evaluation, and communication. A system usability scale (SUS) questionnaire was used to assess application usability. A total of 20 health cadres (trained community members) and health workers participated in the usability tests. **Results:** Two versions of the application were developed: Android-based for users and web-based for administrators. The Android-based version has four main menus: Find Tuberculosis, Tuberculosis Education, Latest Info, and Profile. The web version is accessible to health workers, as well as the research team and application developers who monitor and manage the user-conducted screenings. The average SUS score was 76 (standard deviation, 8.00). **Conclusions:** This application was developed to help detect active tuberculosis cases in the community. The SUS results indicate that the application is highly usable. Thus, SIKRIBO is expected to be broadly implemented to increase tuberculosis case detection through active community participation.

Keywords: Mobile Applications, Research Design, Community Participation, Tuberculosis, Internet

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I. Introduction

The World Health Organization reported that in 2019, 10 million people were infected with tuberculosis (TB) and 1.2 million died [1]. The transmission rate of smear-positive tuberculosis patients is 65%, and if a single person with active TB can infect 10 to 15 people, there would be 5.8 million infections within a year [2].

Indonesia has one of the highest TB case counts in the world, and the nation accounts for 10% of the global reporting gap of tuberculosis cases due to low case detection and reporting [1]. As highlighted in the national TB strategy,

active case-finding is the primary focus of TB control. Poor TB case detection in a community may increase that community's transmission rate [3].

Rahayu et al. [4] found that a lack of knowledge about TB symptoms and prevention contributes to delayed diagnosis. A separate longitudinal study indicated that only 52.5% of patients who began treatment were aware that cough was a symptom of TB. Those with undiagnosed TB act as reservoirs for transmission to their families [5].

The case notification rate (CNR) is an indicator of the scope of TB case detection. The Central Java TB CNR fell from 157 per 100,000 population in 2019 to 111 per 100,000 population in 2020 [6]. The TB CNR in Semarang (the capital city of Central Java Province) decreased from 258 per 100,000 population in 2019 to 155 per 100,000 population in 2020. In 2019 in Semarang, 1,653 TB cases were identified [7].

The Sekaran Public Health Center (PHC) identified 329 suspected TB cases in 2021 [7]. However prevalent the disease, community-based case-finding has not been conducted actively. One initiative of the Sekaran PHC involves the selection of individuals, termed health cadres, to empower the community in identifying TB cases. These community members can play a central role in family health and are trained for the early detection of TB symptoms in their family members, allowing for prompt and adequate treatment.

The coronavirus disease 2019 pandemic brought numerous challenges to tuberculosis treatment efforts, particularly in case detection. Direct contact had to be avoided, especially with individuals with cough symptoms [8]. However, direct physical contact can be replaced by virtual contact to diminish the risk of exposure. Mobile health (mHealth) applications are therefore a potential solution to the challenges in TB case-finding [9].

mHealth is the application of technology in medicine and public health through mobile devices. mHealth technologies include voice and short messaging services, mobile phone applications (or apps), remote monitoring, and portable sensors. This technology can also be equipped with geographic information and global positioning systems for geographic mapping [10].

mHealth has been recognized as an affordable innovation that can bring high-quality health services to patients in low- and middle-income countries. These countries include Indonesia, due to its poor health systems, high prevalence of tropical and infectious diseases, and high mortality [11]. However, Indonesia ranks fourth in the world in the use of mobile phones, with 61.7% of the population having access to a mobile device [12].

At least 55 mHealth applications related to TB treatment are available [13]. However, only 6% of the 55 mHealth apps focus on TB screening, which is underrepresented in the literature [9,13]. One example, TimBre, is an Indian-based TB app designed for cough screening for the detection of pulmonary tuberculosis. Another, Si Tubo, was made in Indonesia and facilitates the early detection of tuberculosis symptoms in children [13]. The objective of this study is to present comprehensive documentation of the development and usability testing of SIKRIBO, a tuberculosis screening application.

II. Methods

The SIKRIBO application was developed using design science research methodology. This approach provides a practical framework for developing, implementing, and evaluating the designed artifact with a focus on enhancing functional performance [14]. The six activities of this methodology are explained as follows and detailed in Figure 1.

1. Identifying Problems and Motivation

Preliminary field studies were conducted to identify the challenges associated with detecting TB cases.

2. Defining Objectives of a Solution

Literature reviews were conducted to build on prior research, map the issues, and determine a solution. Addition-

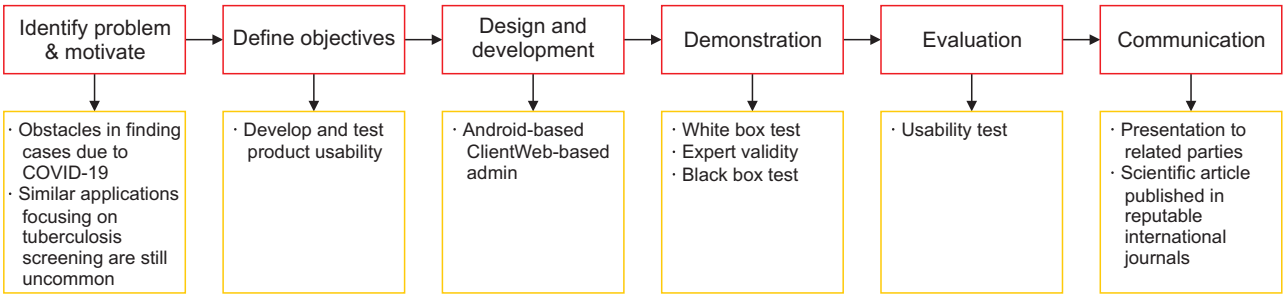

Figure 1. Design science research methodology process model for the SIKRIBO application.

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ally, studies of the evaluation and testing of various TB apps were reviewed. The goal was to document the development and usability testing of Android-based applications for the detection of active TB cases.

3. Product Design and Development

The SIKRIBO app was created using rapid application development, which produces higher-quality results much faster than other software development methodologies [15] (Figure 2).

In the first stage (analysis and quick design), a data flow diagram was created to define how the application collects and delivers data (Figure 3). The application involves interactions between agents as users, the application as a tool, and the responses of the respondents; to accommodate these interactions smoothly, the application must be well-designed. A class diagram (Figure 4) was also created to define the properties and actions of each entity using the app.

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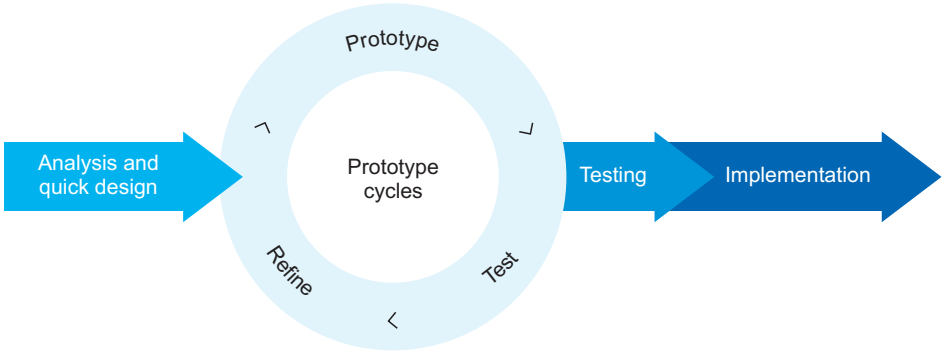

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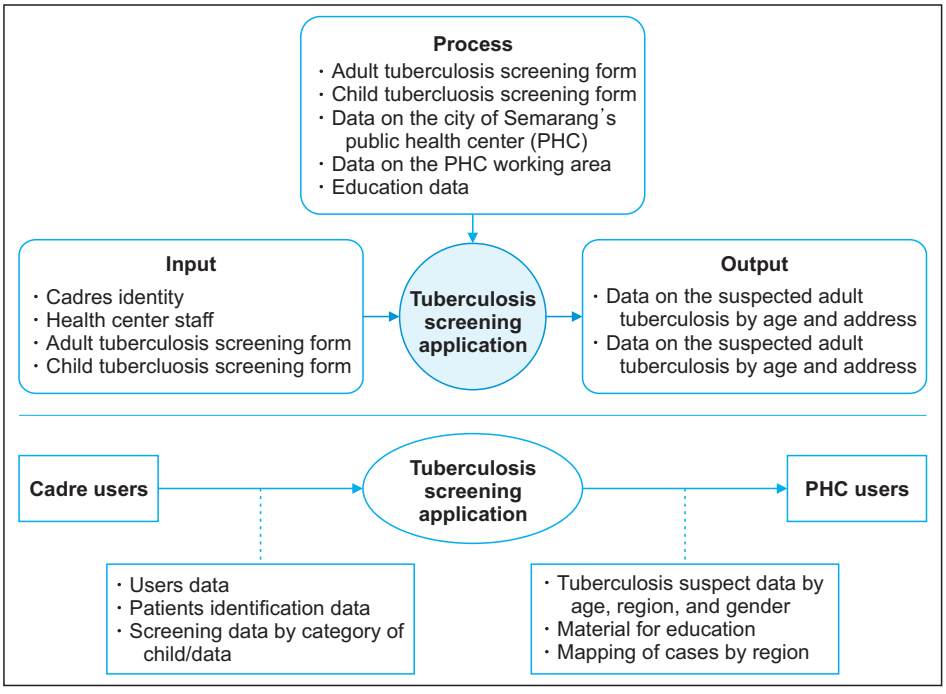
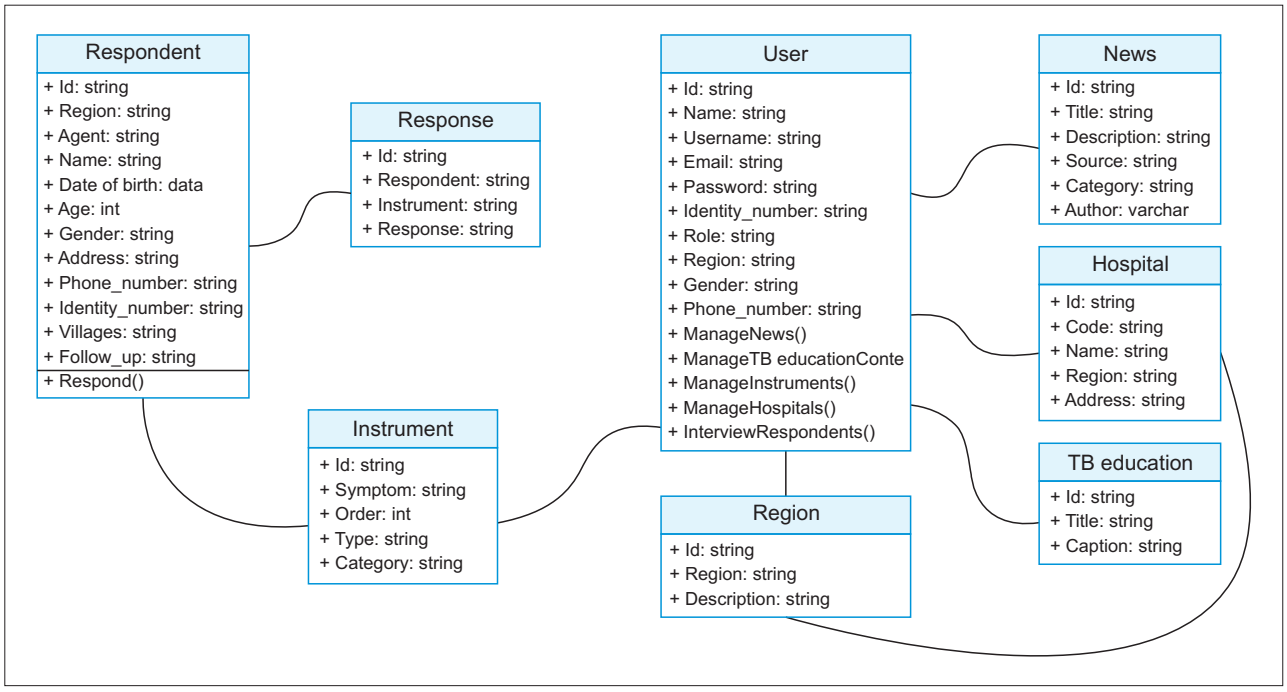


Figure 3. Data flow diagram for the SIKRIBO application.



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By analyzing the internal structure of a software program, white-box testing can uncover system implementation errors, such as poor key management. Path coverage testing was used to understand the cyclomatic complexity of the system.

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Usability testing is used to determine the extent to which a product allows users to achieve specific goals. The effectiveness, efficiency, and satisfaction of using a product are considered [16].

1) Research population and design

A cross-sectional design was used to evaluate the usability of the SIKRIBO app. The sample population included health cadres and health workers at Sekaran PHC in Semarang whose ages ranged from 17–65 years. The sample was designed to reflect the target users of SIKRIBO, who will be conducting TB screening for the public.

2) Sample size determination

Based on the findings of Nielsen [17], 20 respondents were chosen for the usability trials [18]. The sample was selected via convenience sampling, which is the most common method for usability studies [18]. Sampling was carried out at the Sekaran PHC in Semarang as a pilot health center.

3) Research instrument

The system usability scale (SUS) was chosen for the usability testing of the SIKRIBO app. This instrument is a well-validated measure of mobile application usability in questionnaire-based studies [19,20]. The SUS used in this study had been adapted into the Indonesian language, validated, and evaluated for reliability (Cronbach $\alpha = 0.841$) [16]. Additionally, a kappa analysis of the SUS instrument was conducted to measure the agreement between two raters; this yielded a fairly high kappa value ($\kappa = 0.494$), indicating moderate agreement.

The SUS consisted of 10 statement items with favorable

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odd-numbered statements and unfavorable even-numbered statements. Responses were categorized as positive, neutral, or negative. Responses were considered positive if the respondent chose a score of 5 or 4 for odd items (favorable statements) or a score of 1 or 2 for even items (unfavorable statements), neutral if a score of 3 was selected, and negative if the respondent chose a score of 1 or 2 for odd items or a score of 5 or 4 for even items. Akmal Muhamat et al. [19], this system can counteract habitual bias in respondents.

For the favorable items, the individual item score was the scale position minus 1, and for the unfavorable items, the item score was 5 minus the scale position. The overall SUS score (ranging from 0 to 100) was obtained by adding the item scores and multiplying by 2.5. A product is considered to have good usability and high acceptance if the overall SUS score is 68 or higher [19].

4) Data collection

The participants were asked to install the SIKRIBO app on a smartphone by downloading it via the Google Play Store. They were told to utilize all functions of the application, including conducting TB screening independently and with other respondents. Participants were then asked to complete the SUS questionnaire.

5) Data analysis

The SUS results were calculated using Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) and analyzed using SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA) software.

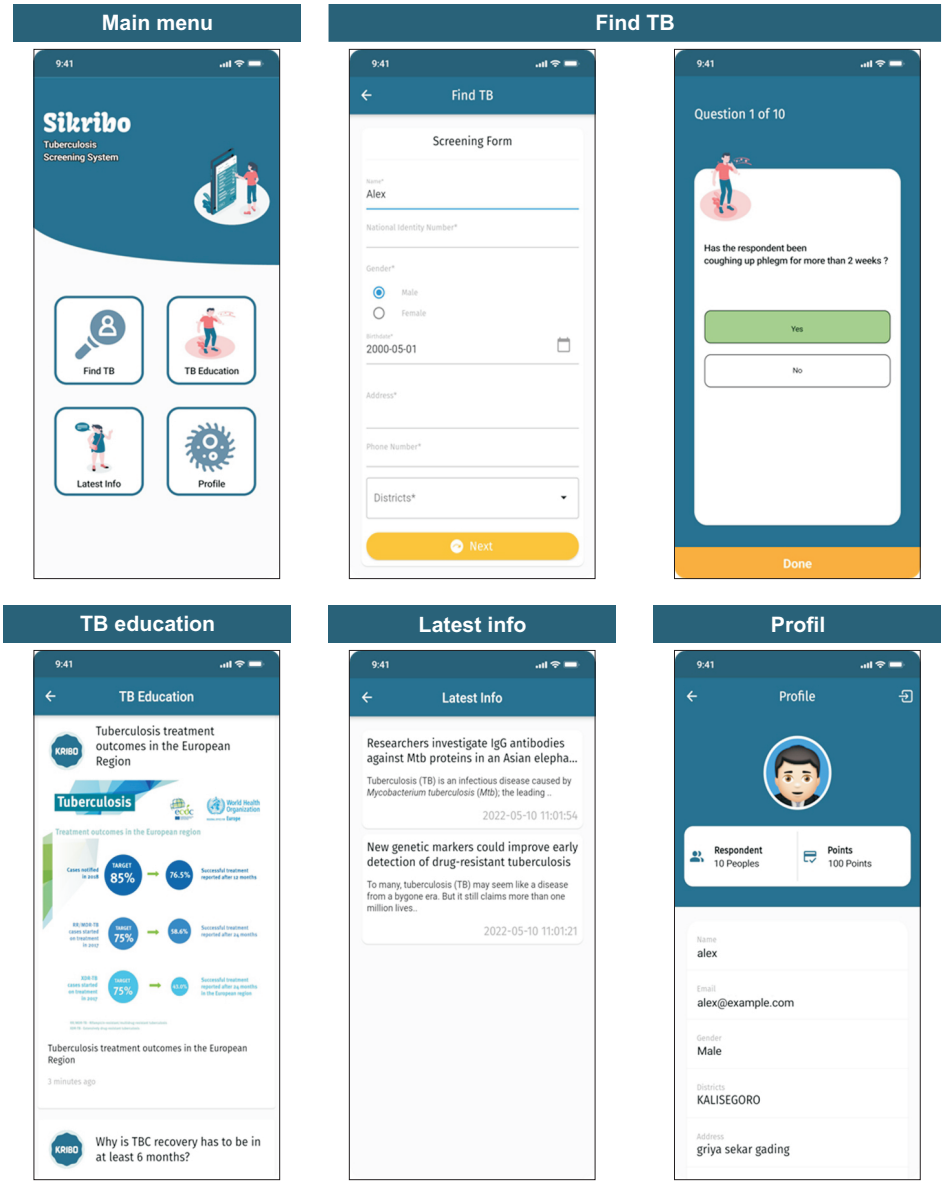

Figure 5. Display menus for the client-based Android application: Main Menu, Find TB, TB Education, Latest Info, and Profile. TB: tuberculosis.

6) Ethical considerations

This study was approved by the Health Research Ethics Commission of the Department of Public Health at Semarang State University (No. 096/KEPK/EC/2021). All participants provided informed consent.

6. Communication

The final stage is communication. After evaluation, the results of product development and product evaluation are communicated to experts, target subjects, and the public. In this study, the communication stage is carried out by documenting the results of research in the form of scientific publications in reputable international journals. In addition, researchers conducted socialization of the SIKRIBO application to various primary health services in the city of Semarang and its surroundings.

III. Results

1. Product Design and Development

The tuberculosis screening application has two versions.

1) Client-based on Android

The Android version is used to collect patient screening data. It has four main menus, shown in Figure 5.

(1) Find TB

This is a form that cadres must complete when performing early screening for TB in the community. The TB screening form contains 10 questions about TB symptoms based on the World Health Organization guidelines [21]. An individual with one of these symptoms is categorized as having suspected TB. This menu includes a personal data form for the person being screened. The screening results (healthy or suspect) can be seen in the Profile menu. Figure 6 shows the steps for TB screening with this application.

(2) TB Education

This menu contains TB-related information, intended to provide the community with knowledge about the disease.

(3) Latest Info

This menu displays the latest information about TB. The information was obtained from trusted sources that are expected to provide updated information about TB to combat the spread of TB-related hoaxes in the community.

(4) Profile

When a user logs in with a Google account, the profile menu automatically displays that user's name and email address. The goal is to provide user data to PHCs to help maintain future communication regarding TB screening follow-up.

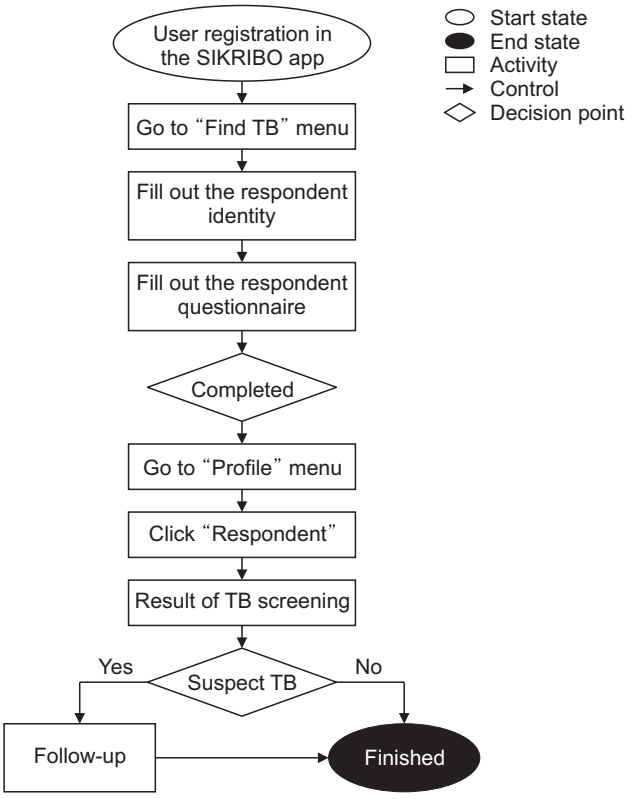

Figure 6. Flowchart of tuberculosis (TB) screening using the SIKRIBO application.

2) Web-based Admin

The web version is accessible to health workers, as well as the research team and application developers who monitor and manage the user-conducted screenings (Figure 7).

2. Evaluation (Usability Testing)

1) Sociodemographic characteristics

Usability testing included 20 participants with the demographic characteristics presented in Table 1. The most common age range for participants was 17–25 years old (40%). The highest education level of most respondents was the tertiary level (70%), and 90% of respondents were female.

2) Usability testing

Usability testing can be used to uncover and troubleshoot any unintended actions taken by users of mobile-based applications. As shown in Table 2, almost all statements had more positive than negative responses. Statements 1 and 7 had the highest percentage of positive responses (95%). Statement 10 had the highest percentage of negative responses, at 50%. The highest average score was for the third statement, about the user-friendliness of the application, at 3.4 (standard deviation [SD], 0.68), and the lowest aver-

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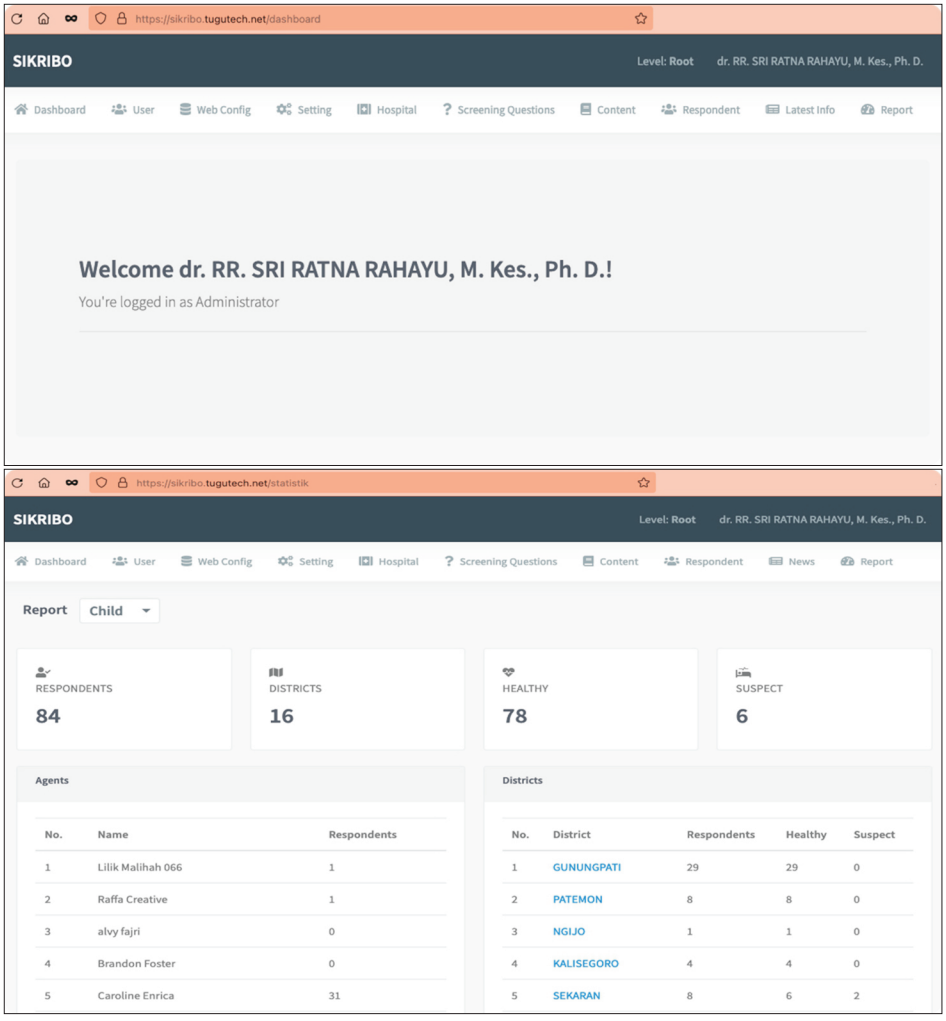

Figure 7. Web-based admin display.

Table 1. Sociodemographic characteristics (n = 20)

Variable	n (%)
Age (yr)	
17–25	8 (40.0)
26–35	5 (25.0)
36–45	4 (20.0)
46–55	2 (10.0)
56–65	1 (5.0)
Education level	
Elementary school	1 (5.0)
Junior high school	1 (5.0)
Senior high school	4 (20.0)
College	14 (70.0)
Sex	
Male	2 (10.0)
Female	18 (90.0)

age score was 1.7 (SD, 1.22) for statement 10, related to self-adjustment before app use. The SUS score was 76, which exceeds the system's minimum usability score (68). The application thus has high acceptance and good usability. The usability score results are detailed in Figure 8.

IV. Discussion

Participants in the usability test displayed relatively high satisfaction with the SIKRIBO app. Most respondents indicated that they would use the application again, due to its ease of use. This finding is promising because user retention is a challenge in the development and implementation of mHealth [22]. According to Akmal Muhamat et al. [19], the ease of use of a mobile application is associated with the user's intention to use it again. The respondents also agreed that the SIKRIBO application features run properly and are well integrated. In fact, almost all respondents agreed that most people would quickly learn how to use this application. This is possible because the SIKRIBO app was developed

Table 2. Usability testing (n = 20)

	Statement	Response			Score
		Positive	Neutral	Negative	
1	I think that I would like to use this application.	19 (95.0)	1 (5.0)	-	3.3 ± 0.6
2	I found application unnecessarily complex.	17 (85.0)	3 (15.0)	-	3.1 ± 0.6
3	I thought application was easy to use.	18 (90.0)	2 (10.0)	-	3.4 ± 0.7
4	I think that I would need the support of a technical person to be able to use application.	15 (75.0)	3 (15.0)	2 (10.0)	4.0 ± 1.1
5	I found the various functions in application were well integrated.	18 (90.0)	2 (10.0)	-	3.2 ± 0.6
6	I thought there was too much inconsistency in application.	16 (80.0)	2 (10.0)	2 (10.0)	3.0 ± 0.9
7	I would imagine that most people would learn to use application very quickly.	19 (95.0)	1 (5.0)	-	3.4 ± 0.6
8	I found application very cumbersome to use.	16 (80.0)	3 (15.0)	1 (5.0)	3.1 ± 1.0
9	I felt very confident using application.	18 (90.0)	2 (10.0)	-	3.4 ± 0.7
10	I needed to learn a lot of things before I could get going with application.	5 (25.0)	5 (25.0)	10 (50.0)	1.7 ± 1.2
Total responses		161 (80.5)	24 (12.0)	15 (7.5)	
SUS score					76 ± 8.0

Values are presented as number (%) or mean ± standard deviation.
SUS: System Usability Scale.

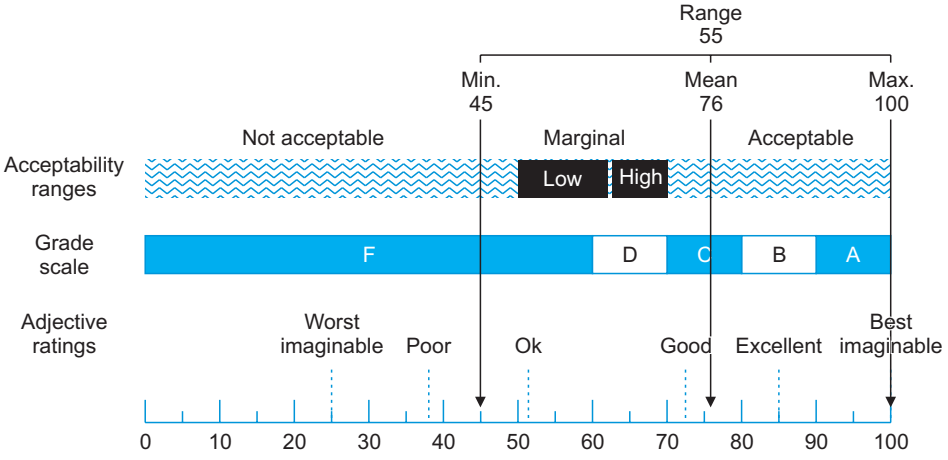

Figure 8. Overview of modified SUS rating table with study results. Adapted from Idrus et al. Health Reg Issues 2020; 22:S57 [25].

with easily understandable features common in mobile applications, with the goal of facilitating broad user-friendliness.

However, one-half of the respondents reported that a steep learning curve was required before using the application. This aligns with the findings of Pande et al. [23], in which as many as 50% of respondents provided a similar response. This is understandable given that new technology necessitates user adaptation. One challenge in implementing mHealth is taking the time to study the app before deploying it. Experts must be able to explain the benefits of the application to users before they are willing to adopt it into clinical practice [24].

The higher the SUS score, the more usable the system. In the present study, the mean SUS score was 76 (SD, 8.00), indicating good usability. Similarly, Idrus et al. [25] found an average SUS score of 77.7 for web-based human immunodeficiency virus and tuberculosis therapy management applications. In another study, the average mHealth SUS score was 80.5 (SD, 11.47), indicating good but not excellent usability [26].

The main purpose of the SIKRIBO app is to assist in early TB case detection in the community by utilizing digital technology. Screening through symptoms is an easy way to identify TB cases in the community. Moreover, involving the community in TB screening increases the rate of TB detection. The SIKRIBO app can help health facilities conduct TB screening in the community by involving the community as cadres. The results of these screenings are recorded in the

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web-based admin version of SIKRIBO to monitor cadres in screening and follow-up suspected TB cases for diagnostic examinations. Even the public can use SIKRIBO for self-screening.

mHealth can be used to help screen for infectious diseases and strengthen infectious disease surveillance across the globe. In addition, it may increase the availability of scientific research and public health initiatives [27]. Even from the perspective of health workers, as reported by Faujdar et al. [28], such digital systems are making work easier and faster, although adaptation can be slow. The SIKRIBO app is not only a screening application, but also a medium for public education about TB and its prevention, provided in the TB Education feature. Mahmood et al. [29] underscored that smartphones increase the efficiency of health education on disease and its prevention. In line with these potentially great benefits in public health, the SIKRIBO application should be released in a large initial trial for utilization by primary health facilities.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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