A Conceptual Paper: Model of Integrated Surveillance System of Tuberculosis Based on the Internet of Things (IoT) for Accelerating Indonesia Free Tuberculosis in 2030

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A Conceptual Paper: Model of Integrated Surveillance System of Tuberculosis Based on the Internet of Things (IoT) for Accelerating Indonesia Free Tuberculosis in 2030

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***Abstract*—Tuberculosis (TB) remains a public health problem in the world. Second disease causing death after Covid-19. In 2020, case findings of TB cases in Indonesia slightly decreased compared to 2019, from 568.987 to 351.936 cases. To combat the disease, Indonesia has adopted the End TB program, targeting to reduce TB incidence to 65 cases per 100,000 population by 2030. At the same time, many challenges need to be overcome, such as low coverage of TB treatment, delay of diagnosis and treatment, and other factors associated. This paper aims to propose a model of an Integrated Surveillance System of Tuberculosis Based on the Internet of Things (IoT). The research will employ the End-to-End Life Cycle Automation System approach. Data collection will use two sources of data, primary and secondary data. The various research instruments (Questionnaire, interview guidelines, checklist observation, and IoT) will be used to capture primary data in this research. Secondary data sources will use reports of TB in multilevel (district/city, province, and national level), medical records of TB patients, news of TB prevention and treatment programs, demography and geography information, and poverty level. The data will produce a model of an integrated surveillance system. The field test will be conducted on the design and continuously improved based on the result. The information provided by the system will be available on a dashboard as a data visualization that can be easily accessed. This system will provide rapid and precise analysis to help the government achieve the Free TB agenda 2030. The system will help develop an effective and efficient TB prevention program in the community for health services based on their need.**

Keywords*—Tuberculosis, Integrated Surveillance system, Internet of Things, Artificial intelligence

I. Introduction

Tuberculosis (TB) remains the leading cause of death globally and an infectious disease with a high mortality rate after Covid-19. Indonesia became the third country after India and China, with the highest burden of TB globally [1]. Indonesia contributes 14% of the global drop in TB notification rate [2]. In 2020, TB case findings decreased from 568.978 cases in 2019 to 351.936 cases. The treatment coverage only reached 41.7% in the same year, which means the cases found were not all accessing the medication. Compared to Indonesia's national target (80%), the treatment coverage number remains low [1].

Indonesia has adopted the End TB program, targeting to reduce TB incidence to 65 cases per 100,000 population by 2030 [3]. Even though the situation remains significantly unchanged, marked by the slow progress of controlling the epidemic, both transmission and treatment. Controlling TB transmission factors, including housing determinants (density index, ventilation, and indoor air pollution), education, access to a health facility, and nutritional status need to be done [4].

Research showed that 31% of patients with TB symptoms did not seek any treatment. The delays in diagnosis and treatment of TB become a critical challenge to TB transmission control [5]. The delays can contribute to severe cases, broadly transmission of TB, and more costly of seeking care [6]. The delays are categorized as patients and provider delays. Patients' delay related to socio-demographic characteristics (male, low education, low-income level, and rural area), TB symptoms had experienced, medical examination, and condition of seeking medical care [7]. Research showed that most patients experienced complex processes both in private and public health services to receive a diagnosis [8].

Provider delay is related to the distance of health services. Patients who experienced the first consultation with a public hospital had shorter provider delays. In contrast, long travel time or distance to the first healthcare provider may have longer delays [7]. The geographic issues can also influence the timeliness of medical services, particularly in remote and poor areas [9]. Also, it can affect the success rate of TB treatment.

In 2021, Indonesia became one of the ten countries that account for about 70% of the global gap between the estimated global incidence of MDR/RR-TB each year and the number of people enrolled in treatment [2]. There is an insignificant result in Indonesia compared to India and

China in increasing the treatment rate of TB. It is more likely that in Indonesia, the proportion of active TB patients receiving the treatment is marginal, and case holding control is less effective [10].

The complex factors become a critical challenge to the eradication program of TB in Indonesia. It is needed to integrate all the elements to develop a specific program supporting the End TB strategy. The research found that using an electronic system increases health providers' effectiveness in performing their tasks [11]. The study aims to propose an integrated surveillance system of tuberculosis model based on the internet of things (IoT) to accelerate Indonesia's free TB in 2030.

II. METHODOLOGY

The research will employ the End-to-End Life Cycle Automation System methodology (Figure 1). The first process initiates with data collection covering various data sources and methods. The second process continues with data cleansing, and the process determines data features and finds the relationship within variables by using a machine learning process with appropriate algorithms. The third process will use the result for applications portfolio to enhance organization strategies and programs. The application can visualize the organization's performance for continuous quality improvement [12].

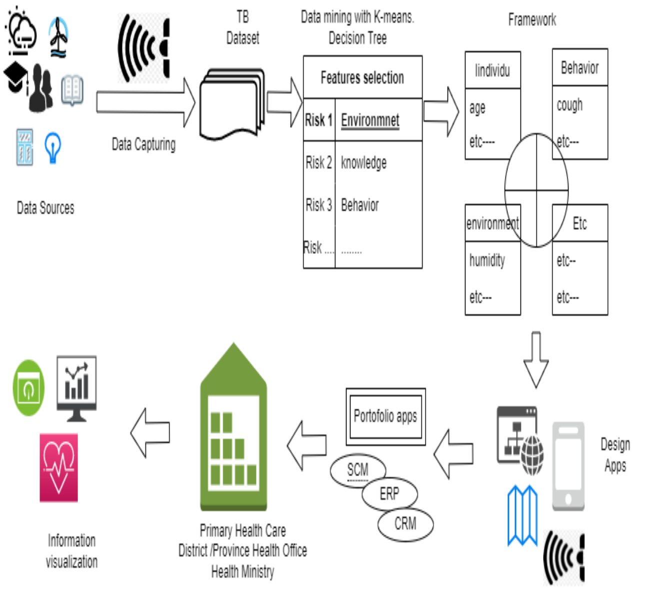

Figure 1. Research Flow Chart

Data collection will use two sources of data, primary and secondary data. The various research instruments (Questionnaire, interview guidelines, checklist observation, and IoT) will be used to capture primary data in this research. A questionnaire will collect TB patients' behavior, knowledge, attitude, and health literacy data. The questionnaire will be developed and validated before its use. Interviews with health services staff will be conducted to gain information on TB facilities and programs. Observation and IoT will capture environmental data (humidity, ventilation, and house index) for six months (long treatment of TB patients). Besides, secondary data will also collect to enrich data sources and analysis.

Secondary data sources are reports of TB in multilevel (district/city, province, and national level), medical records of TB patients, news of TB prevention and treatment programs, demography and geography information, and poverty level. The result of primary and secondary data capturing will be analyzed using machine learning with K-Means and Decision Tree approach to developing an initial model.

The data set process will be analyzed using the steps followed: Data Preprocessing (missing data, removing duplicate, outlier data, balancing data, normalizing data), Data Processing (data mining with Algorithm K-Means and prescription), and Tools development.

The first step in data preprocessing will check primary and secondary data for missing values. This step aims to make sure all the data is complete. In the second step, duplicated data will be removed, which is the data with the same exact information will delete from the dataset. The third step is checking the outlier and removing the outlier from the data set. Then, balancing the data and test normality data. The final result of these steps is a suitable dataset ready to analyze.

The data processing step is the analysis step. This step will use the algorithm K-Means in data mining to produce a model. The dataset will be divided into data training and data testing. Algorithm K-Means in data mining will be used to process the data training. The model produced by data training will be tested with data testing using the same algorithm. This step will check the value of model precision. After the model is considered a good model, we will develop a prescription based on the cluster produced in the earlier step. The prescription will deploy into the model.

The tools development step aims to develop the ready model and deploy it into devices such as computers or mobile phones. In this step will also conduct training for health services staff, health cadres, and the community. The initial model will be used as a strategic framework and developed as an integrated surveillance system for tuberculosis prevention and control. The field test will be conducted on the system and continuously improve based on the result. The information provided by the system will be available on a dashboard as a data visualization that can be easily accessed.

TAM will be used to evaluate the system to measure the success of the technology adoption. Previous research found that users' perceived usefulness affected behavioral intention to use ERP. At the same time, the usefulness perceived influenced behavioral intention towards use. The internal collaboration involved both perceived effectiveness and ease of use [13].

III. FUTURE RESULT

The integrated surveillance system for tuberculosis prevention and control will use IoT and AI to capture data in real-time and quickly produce a result. The application of the IoT and AI showed below (Figure 2)

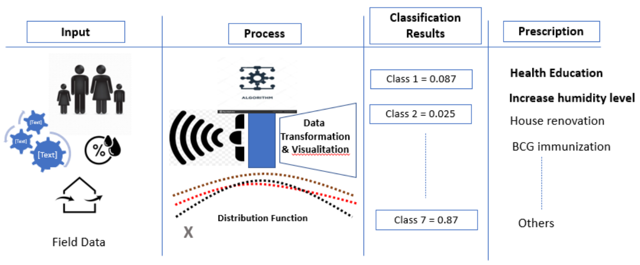

Figure 2. The Implementation of the Internet of Things (IoT) and Artificial Intelligence (AI) on the integrated surveillance system for tuberculosis prevention and control

The system will use IoT to capture field data quickly and effectively. The collected data will transform and analyzed with machine learning. The transformation and data analysis steps are classifications, prediction, and prescription. The classification process will produce the risk level of TB transmission in areas that will show with the geographic information system (GIS). The risk level will be classified into three categories; low, medium, and high risk of transmission. Based on the classification result, the system will analyze the existing program and predict when the number of TB cases increases significantly. The prediction process will produce a class based on the higher risk to low risk of increasing the TB incidence. After that, the system will provide a prescription showing what prevention program needs to address (health education, immunization program, house renovation, etc.) based on the class.

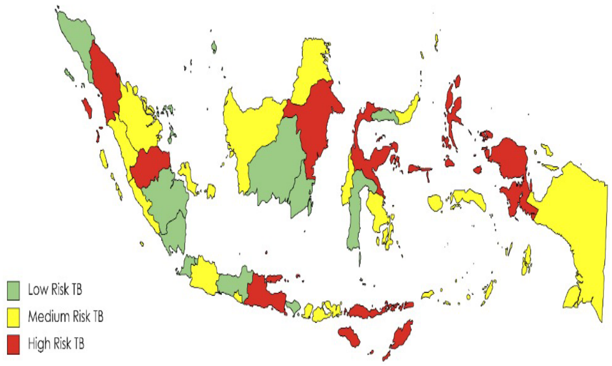

Figure 3. Illustrated Result of Classification Process

The classification process's future result shows in figure 3—the classification of risk transmission of TB. The map will be able to provide through a trim level area (village). The color represented the risk, Red: high-risk TB transmission, Yellow: Medium Risk TB transmission, and Green: Low-risk TB transmission. The classification will base on multiple factors (number of TB incidence, environmental factors, a success rate of TB medication, health literacy, etc.). The next step is prediction. The prediction process will result in the class of TB transmission based on the prediction value. Each value will refer to a prescription that shows the program needed for TB prevention in the area.

IV. Conclusion

We will establish big data from multiple sources and instruments from this research to collect the data (validated questionnaire, interview guidelines, checklist observation, and IoT). This research will improve TB data quality in the field and integrate analysis using IoT and AI technology. The research will also produce a system that will provide rapid and precise analysis to help the government achieve the free TB agenda 2030. The system will help develop an effective and efficient TB prevention program in the community for health services based on their need.

The system will help classify high-risk areas and provide a prescription for preventing TB transmission to public health, especially health-promoting staff. This research is also in line with the WHO agenda for combating TB infection.

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