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Bioinformatics and Biological Data Mining

Biomedical Engineering and Technology

How Big Data in Health 4.0 Helps Prevent the Spread of Tuberculosis

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***Abstract*—Internet development has initiated an industry 4.0 evolution, where the production process can be arranged virtually and connected with large data services. The use of big data in all fields now also impacts on the health sector better known as health 4.0. This study analyzes the use of big data in the era of industry 4.0 in the health domain with the aim of knowing how much the benefits of big data technology and health 4.0 can help prevent the spread of infectious diseases. In this study, we took papers online and conducted an analogous review process. The results of the paper that we reviewed further provided us with an overview and proposal for a scheme for monitoring infectious diseases such as TB by utilizing big data. And open new opportunities to understand public health and the prevention of infectious diseases in the health era 4.0.**

Keywords— big data, health 4.0, monitoring, prevention, tuberculosis

I. INTRODUCTION

The tuberculosis bacterium is a bacterium that infects more than one-third of the population worldwide and TB infection is still the first cause of death in Indonesia [1]. Like other developing countries which are endemic to TB, Indonesia is the country with the second largest number of TB in the world in 2017 [2]. Ineffective prevention measures cause loss of 20% of total sufferers in Indonesia, even two-thirds of the total TB sufferers in Indonesia in 2015 do not know or are not informed of the status of their TB condition [3]. Effective steps and the application of information technology for the prevention of TB in endemic countries such as Indonesia are needed. The role and industry 4.0 in the health area is a challenge in itself to help treat TB disease [4]. Information technology is currently entering the 4th generation industry era or industry 4.0. Industry 4.0 Health 4.0 is a tactical deployment, and managerial model for health care inspired by Industry 4.0. Health 4.0 must enable gradual virtualization to support personalized health services near real-time for patients, workers, and formal and informal caregivers [5].

Big data in the industrial health domain 4.0 has several important characteristics, namely volume, speed, variation, truth, value and variability. This big data characteristic is related to the parts in the study of the relationship between patient priorities and real-time remote health monitoring system monitoring. Big data refers to large amounts of information consolidated analyzed by certain technologies and applied to the health sector, it will use certain health data from a population and potentially help prevent epidemics and cure diseases as in monitoring TB disease [6]. In addition, big data can also play a role in obtaining a patient's personal data and will reduce hospital errors in providing medication. This usually occurs because the hospital lacks data from these patients, with big data this will not happen [7]. This study is an analytical review study on the role of Bigdata in the industrial era 4.0 on the health domain. With our focus on the use of large data and modelling approaches in health 4.0 such as the use of machine learning, IoT, and sensors, to monitor and prevent infectious diseases. We proposed suggestions for prevention of TB with the help of big data and technology at health 4.0.

II. LITERATURE REVIEW

There are several research studies on efforts to address the prevention of tuberculosis in developing countries such as Indonesia, such as the use of the patient pathway analysis (PPA) method to monitor tuberculosis patients whose whereabouts are unknown because they are no longer doing therapy even though the therapy is not finished [3]. A scientific research presentation on efforts to prevent tuberculosis using big data and prediction methods using artificial intelligence algorithms with statistical parameters. the value that is referred to is based on the income groups of the population in the whole world and the results obtained by the prevention level are very satisfying.[8][9]. The use of big data in the health area has been very popular nowadays especially for era industry 4.0 in the health area, such as in developed countries using big data to monitor patients health by implanting biosensors [10][11].

In some literature it explains that the role of big data in industry 4.0 and the health domain is an important step to provide health care more leverage such as detecting emergency conditions in patients with cardiovascular disease, this is a creation that supports industry 4.0 in the health space [11] [12]. In detecting data characteristics of the data sources used already have 5 characteristics, namely Velocity, Volume, Value, Variety, and Veracity.Today in many countries begin to use the learning domain health engine to predict dangerous diseases based on medical history, and this cannot be separated from the role of big data [9]. The role of big data in the medical area is not just a provider of information but also clinical research to support important decision in the medical area [13].

In this study, the role of industry analysis 4.0 and the use of Big data to support infectious prevention in special developing regions in Indonesia, the role of Big data in the cloud can be expected to help monitor sufferers of infectious diseases such as Tuberculosis. This research is expected to provide input in seeking steps to prevent the spread of infectious diseases, especially TB, by conducting more intensive monitoring using e-health services and sensors integrated into hospital services.

III. METHOD

To answer the research questions outlined in the previous section, we survey published papers in international publications with high impact factors, between 2015 and 2019. In addition to the publication period, we also use special criteria, namely the publication of full articles and papers that have relevance to research questions. The methodology of this research can be seen in Fig. 1.

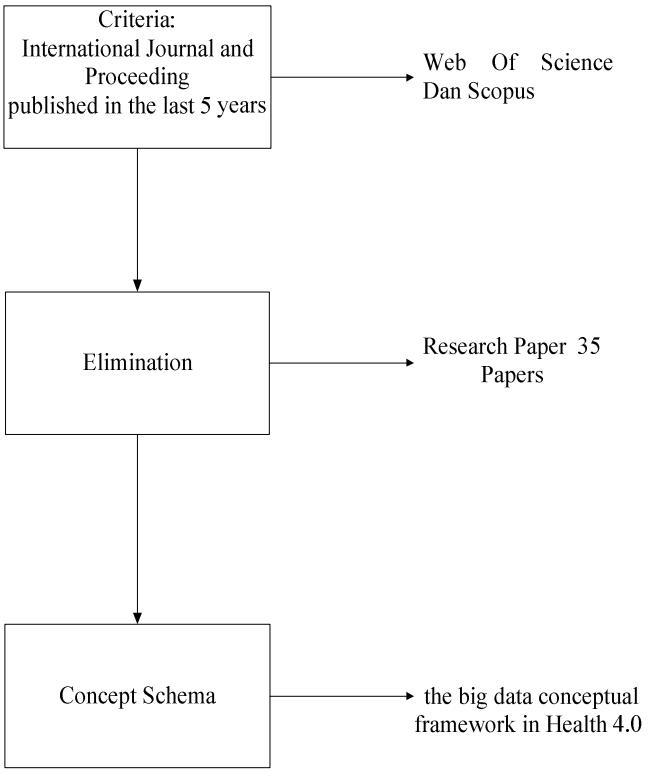

Fig. 1. Research method.

In Fig.1, the survey literature can be explained by following a systematic approach. This is done in three steps. In the first step, we looked for two main bibliographic databases, Web of Science and Scopus, using all combinations of two groups of keywords. The first keyword must be from the group that discusses Big Data and machine health learning 4.0 (ie Big Data, data-based innovation, data-based value creation, internet of things, mIoT) and the second group refers to health (ie care, care, and communicable diseases)). The two databases were chosen because of the variety of relevant literature and provide good journals such as suggested literature or related citations. Of the many types of literature selected based on these two groups of keywords, we eliminate based on relevance by identifying sections that address the research question. at the elimination stage we get 35 papers that fit the research topic we discussed. Then in the final stage, based on the paper chosen we analyzed the big data technology in health 4.0 with a focus on preventing infectious diseases**,** which then proposed a contagious disease prevention scheme based on framework health 4.0.

To facilitate the deliver we make a schematic diagram consisting of the points displayed, shown in Fig. 2.

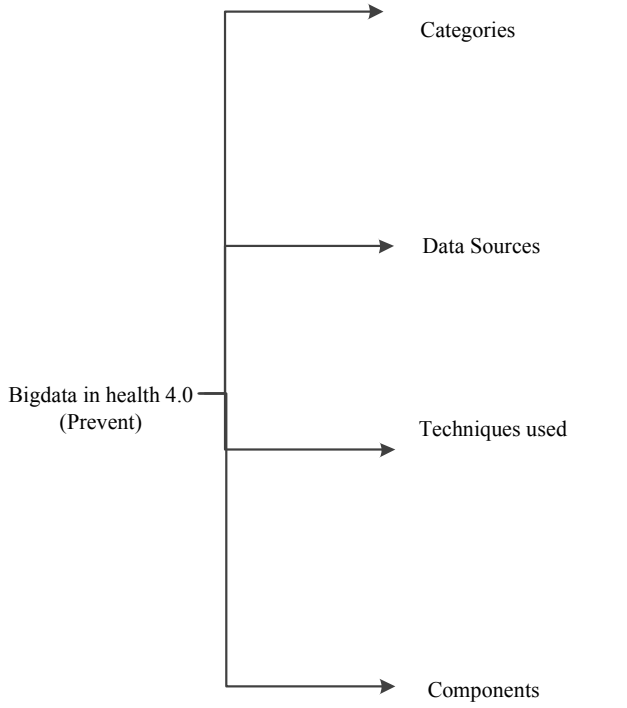

Fig. 2. Schematic diagram of the paper structure.

In Fig. 2, describes the structure of the discussion that we will explain in this study regarding the role of big data in the health industry 4.0 domain. To be able to understand more deeply based on the analogy concept, we included five results of the discussion based on previous research. The results of the discussion include categories, data sources, algorithm/method, and tools.

IV. RESULT AND DISCUSSION

Health 4.0 is a new concept, although there is not much literature presenting the prevention of infectious diseases in the industrial era 4.0, there have been many papers that discuss the role of health 4.0 in health, especially for the prevention and cure of vascular disease. In this study, we review the role and use of large data in the health sector as a technology that supports the prevention of infectious diseases such as HIV, Tuberculosis, Hepatitis, influenza, etc. In comparison, we took a number of examples of diseases that have gotten a touch of industrial era 4.0. so as not to get out of the subject of discussion about disease prevention. While the purpose of taking the concept of comparison is as relevant to the scope of the study. Whereas the scope of prevention includes monitoring and analysis of clinical data; early disease monitoring and warning; daily activity data and detection and collection of patient's vital signs.

To find out more in detail the influence of big data technology in era 4.0 in contributing to disease prevention, we included 4 structures in a diagram schema based on a preventive approach.

A. Category

Prevention of infectious diseases has become an important problem in developed and developing countries [14]. Big Data in the care and prevention of infectious diseases can be made as an alternative technology that supports the medical world in terms of prevention. To find out more in detail the influence of big data technology in contributing to disease prevention. We included several categories based on the prevention approach, as shown in TABLE I.

TABLE I. CATEGORY PREVENTIVE OF DISEASE

Sources	View Category of Preventive	Description of Disease
[10][15][16] [17][18][19] [20][21]	Monitoring and controlling	telemedicine and telehealth, heart, cronically monitoring, Multiple sclerosis, chikunya virus.
[20]	Warning	Heart therapy, stroke
[8][22]	Detection	HIV
[15][23][16]	Daily Activity	Parkinson, obesity,
[4]	Medicine/ farmacy/therapy	Tuberculosis therapy Therapy Failure
[7][8][9] [19][22] [24][25]	Prediction	Disease, tuberculosis, brain/stroke, prediction of treatment, psychiatric, HIV

Based on TABLE I., it can be illustrated that several studies on the use of big data in the health area have many objectives for monitoring, controlling, and predicting. Some diseases that are mostly chronic diseases and blood vessel problems such as heart and stroke have used technology in the health era 4.0 such as telemedicine and telehealth [11][15]. Even though there is not much use of technology 4.0 in the field of infectious diseases. Supervision and control, although the use of large data for infectious diseases such as tuberculosis and HIV are often carried out especially in developing countries. From some existing literature that explains the level of knowledge that is still low is the main element of failure to prevent infectious diseases. Besides that support for using technology is still lacking.

B. Data Sources

Integration of multi-source medical data associates many types of data in the health industry including data on prevention of infectious diseases. Data integration comes with frequency often with large volumes in the medical and scientific domain. In developing countries like Indonesia, access to highly sensitive data is a problem where integration requirements are ignored. Especially data are related to medical data, such as patient medical record data. The use of medical data for infectious diseases for research is still difficult to obtain, especially in Indonesia. Regulations governing the confidentiality of medical data are still very conservative. the use of medical data should be able to be opened especially for research. like TABLE II below about medical data on the disease.

TABLE II. DATA SOURCES

Sources	View Data Source	Description
[4][10][15][16] [19][22][23][24]	Psychiatric hospital,general hospital	
[8] [25]	WHO, bank data, online data	Open source

Some of the Big Data that can be taken as open source as in the World WHO Institute for handling HIV prevention, Tuberculosis globally [8]. But some literature explains the use of data taken from hospitals [9][19][25], good for monitoring purposes. Controlling, Warning, Detection, prediction, daily activity, medicine / pharmacy, and non-infectious disease therapy. While the data taken for the prevention of infectious diseases with large volumes is still very difficult to obtain because it takes into account the privacy of patients. For example, HIV disease discrimination and tuberculosis, so many patients who did not give up their data were taken as research. This is an obstacle in several studies using data on infectious disease patients.

C. Techniques Used for Preventive Measures

In this study, we show that the machine learning algorithm provides additional information compared to the explanatory model in the previous literature based on prior medical knowledge. Where in reviewing information about big data in the industrial era 4.0, the emphasis is more on Cyber-Physical Systems technology [26] [27]. We include several machine learning techniques, as shown in TABLE III. that can support Big data Technology.

TABLE III. METHOD USED IN MACHINE LEARNING

View technically	Description	Sources
neural network (CNN)	brain infarction, HIV, Tuberculosis, lever, skin cancer, hepatitis	[7] [9] [28]
Naïve Bayesian	Heart, stroke	[15][29]
KNN	HIV, Tuberculosis	[8][22] [30]
SVSA (Support Vector Selection Adaptation)	Parkinson	[16] [23] [30]
Decision Tree	HIV, TB	[31] [30]
Random Forest	HIV	[22][30]

According to TABLE III, it can be seen that the use of machine learning applications plays an important role in supporting important steps in predicting chronic disease, for many infectious diseases there is research using the CNN technique, although this cannot be used as a benchmark for which technique is best. The study was not specifically good for what type of disease. Even so, both conventional machine learning and deep learning [9] very important in supporting health 4.0 industry and big data.

D. Components/ Tools

Health-CPS provides more convenient services and a health care environment including direct user-centered services, where the use of cyber physical systems is the cornerstone of medical services as show in Zhang et al. [27]. The results showed that improving the performance of the health care system for patients over long distances and centering on users could use cloud and big data technology. Based on the literature analysis we include several component elements that support their industry 4.0. In the previous literature, it was explained that industrial component 4.0 also triggered several uses of tools in the medical world. Based on the literature Herman, et al. [26]. This component is divided into 4 parts as in TABLE IV.

TABLE IV INDUSTRY 4.0 COMPONENTS

Sources	Tools	Description
[20] [27][32][33]	Cyber-Physical Systems	medical Internet of Things (M-IoT) Heart rate variability for stress measuring, Glucose measures, Body motion in healthy subjects.
[19][33]	Internet of Things (IoT)	IoT, Homecare sensor system, Implantable sensor, Measuring the sweat sensor system, EMG, ECG, respiration, skin conductivity (EDR), Roll-over detection, sleep quality,
[17][33]	Internet of Services	5G mobile technologies, the Internet, a wireless broadband network, and sensor networks
[26][10][34]	Smart Factories	Virtual Robot, Internet of Things, Big Data, Cloud Computing, Artificial Intelligence, Mobility, Virtual and Augmented Reality, sensor and automation systems.

Based on TABLE IV, technology for the use of electricity in the industrial era 4.0 has a very important role. In the health industry, many hospitals secure sensors in patients' bodies to monitor health such as the use of remote sensors to monitor heart disease patients. Some studies suggest that in industry 4.0 in the healthy domain using Cyber-Physical, IoT and Internet of Services technology facilitates monitoring and prevention of diseases and treatments such as the use of sensors and technology. 5G Different IoT devices are used to capture patient signals and images in a smart home scenario. as an example; These signals are used as input to the emotion detection module. The voice and image signals are processed separately, and classification scores using these signals are combined to produce the final score for making emotional decisions. If emotions are detected as pain, the nurse can visit the patient [35].

From the analysis of the previous literary literature, we agreed that big data technology can be optimized to prevent diseases that have high risks such as heart disease, diabetes, and various similar diseases due to unhealthy lifestyles. Big data can provide predictive analysis to find out bad habits that can be the seeds of future diseases. But what about infectious diseases and their spread? For example, Tuberculosis.

In this study analyses the role of big data in the era of industry 4.0 in the health sector. We try to present a concept of preventing tuberculosis in developing countries like Indonesia. To reduce the spread of Tuberculosis, according to WHO, the cost of treating and preventing TB reaches the US $ 6.9 billion in 2017 in 118 developing countries. The pattern of the spread of Tuberculosis with low income and middle income such as Indonesia in 2017 continues to increase. Increased cases of TB itself because patients who stopped taking treatment and Tuberculosis patients "disappeared" [3]. Today many modern hospitals apply intelligent technology as shown fig. 3.

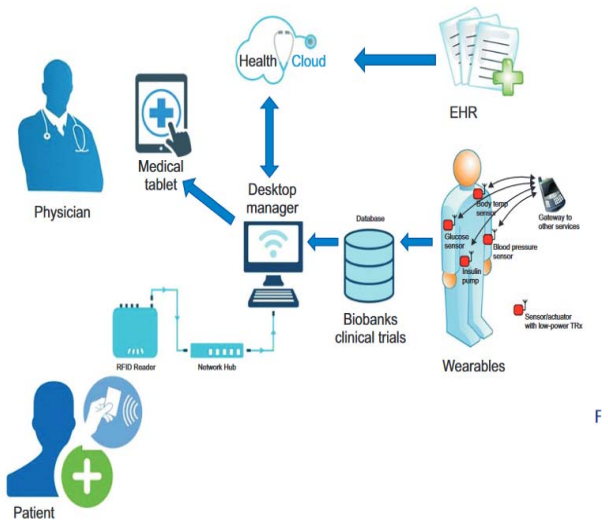

Fig. 3. Illustration Internet of Things (IoT) hospital [15].

Fig. 3 is an illustration of patient care in a hospital with health technology 4.0. where monitoring of patients remotely using sensors installed in the patient's body can maximize care. Stakeholders in the medical world are facilitated by this technology. We assume that this treatment is also done in tuberculosis patients. Making it easier to monitor and prevent tuberculosis. TB patients can use Cyber-Physical System equipment during treatment. The sensor uses sensors that support sending data from TB patients to hospital services as 4.0 health characteristics.

V. CONCLUSION

This study examines presentations and methodologies developed for bigdata on health with objects of health monitoring and reviews the possibility of prevention of infectious diseases in the future. In this survey study, 35 of these publications were selected from large data studies, health 4.0, infectious diseases, and health domain health care recently. After analyzing the relationship between the papers, we selected categories of categories, data sources, techniques used, and tools to understand the needs of large data technology and health 4.0. To our knowledge, there are not many surveys that discuss prevention of infectious diseases using big data technology. this might possibly help researchers to get a full understanding of research related to infectious diseases in the future.

For future research, we propose the use of big data and Cyber-Physical technology, IoT and Internet of Services technology to detect the presence of tuberculosis patients so that the steps to prevent disease through monitoring can be carried out optimally with the help of big data technology.

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