Journal of World Future Medicine, Health and Nursing, 2(2) - May 2024 216-227

The Role of Big Data Technology in Predicting and Managing the Spread of Infectious Diseases

Loso Judijanto [1], Hermansyah [2], Kori Puspita Ningsih [3], Dito Anurogo [4], Mohamad Firdaus [5]

[1] *IPOSS Jakarta, Indonesia*
[2] *Politeknik Kesehatan Kemenkes Aceh, Indonesia*
[3] *Universitas Jenderal Achmad Yani Yogyakarta, Indonesia*
[4] *Universitas Muhammadiyah Makassar, Indonesia*
[5] *Universitas Indraprasta PGRI, Indonesia*

Corresponding Author: Loso Judijanto, E-mail; losojudijantobumn@gmail.com

Article Information:
Received May 10, 2024
Revised May 19, 2024
Accepted May 24, 2024

ABSTRACT

The spread of infectious diseases is a global problem that requires effective approaches for prediction and management. In recent years, Big Data technology has become a major concern in the healthcare field due to its ability to quickly collect, store and analyze large and diverse volumes of data. This opens up new opportunities to improve prediction and management of the spread of infectious diseases. This research aims to investigate the role of Big Data technology in predicting and managing the spread of infectious diseases. We want to identify effective methods for using big data to predict disease spread patterns and manage responses to them. The research method used in this research is a qualitative method in the form of literature analysis about the use of Big Data technology in the health sector, case studies of the implementation of Big Data systems to predict the spread of disease. The research results show that Big Data technology can improve predictions of the spread of infectious diseases by integrating data from various sources, including clinical, geographic, demographic and social data. Integrated Big Data systems can provide a better understanding of the factors that influence the spread of disease and enable faster and more effective decision making in responding to outbreaks. The conclusion of this research is that it confirms that Big Data technology has great potential in improving the prediction and management of the spread of infectious diseases. By effectively leveraging big data, we can improve our understanding of the dynamics of disease spread and implement more timely and efficient intervention strategies. Therefore, further investment and development in Big Data technology in the health sector is essential to strengthen capacity to face global health challenges.

Keywords: *Management, Prediction, Technology*

Journal Homepage https://journal.ypidathu.or.id/index.php/jnhl
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How to cite: Judijanto, L., Hermansyah, Hermansyah., Ningsih, P, K., Anurogo, D., Firdaus, M. (2024). The Role of Big Data Technology in Predicting and Managing the Spread of

Infectious Diseases. *Journal of World Future Medicine, Health and Nursing*, 2(2), 216-227. https://doi.org/10.70177/health.v2i2.757
Published by: Yayasan Pendidikan Islam Daarut Thufulah

INTRODUCTION

In this digital era, Big Data technology has become increasingly prominent in various aspects of human life, including in the world of health (M. Ahmad et al., 2016). Advances in computer technology, the development of data analysis software, and the exponential growth of digital data have opened the door to the use of Big Data in understanding, preventing, and treating various health problems (Shi et al., 2023). With large volumes of data generated by a variety of sources, from electronic medical records to medical sensors and health applications, Big Data offers great potential in improving diagnosis, treatment, disease management and better health decision making. The role of Big Data in healthcare has grown rapidly in recent decades, having a significant impact on various aspects of healthcare and medical research. One of the key aspects of the use of Big Data in health is its ability to collect, store, and analyze large volumes of health data quickly and efficiently (Zhang et al., 2020). Using advanced data analysis techniques such as machine learning and data mining, health experts can identify hidden patterns in health data (Zhang et al., 2019), including patterns of disease spread, associated risk factors, and response to treatment.

The use of Big Data in health also enables the adoption of a more personalized and evidence-based approach to health care (Bansal et al., 2016). By leveraging individual health data, including medical history, lifestyle patterns, and genomic data, healthcare providers can develop treatment strategies tailored to each patient's unique needs and characteristics (Epizitone et al., 2022). This can help increase the effectiveness of treatment, reduce the risk of complications, and improve long-term health outcomes. Apart from that, Big Data also has great potential in improving public health monitoring and surveillance (Yu et al., 2017). By collecting and analyzing population health data from multiple sources, including public health surveillance data, medical sensors, and social media (Hassan Zadeh et al., 2019), health experts can detect spikes in disease cases more quickly, identify high-risk areas, and respond quickly to prevent further spread infectious diseases.

However, while the potential for Big Data in healthcare is enormous, there are also a number of challenges that need to be overcome. One of them is the issue of data privacy and security. Sensitive health data collected and analyzed in the context of Big Data requires strict protection to prevent misuse or privacy violations (Woo et al., 2016). In addition, there are also technical challenges in integrating data from multiple sources with different formats and structures, as well as in managing the large volumes of data generated by Big Data monitoring and analysis systems (Corsi et al., 2021). Given these challenges, further research and development is needed to optimize the potential of Big Data in the world of health and overcome existing barriers (Corsi et al., 2021). Collaboration between governments, health institutions, the technology industry and civil society is also important to ensure that the use of Big Data in health

provides maximum benefits for society as a whole (Awotunde et al., 2021). By utilizing Big Data technology wisely and responsibly, we can take steps towards a better health future, where health decision making is based on robust evidence, personalized, and responsive to individual and population needs (Wang et al., 2018).

The spread of infectious diseases is a complex phenomenon involving multiple factors and mechanisms (Jones et al., 2008). In today's tightly connected global society, infectious diseases can spread quickly and widely, resulting in serious health impacts and even public health crises (Liang et al., 2019). One important aspect in discussing the spread of infectious diseases is the risk factors that influence it. These factors include variables such as the nature of the pathogen, host characteristics, physical environment, and human behavior (Nandi et al., 2019). Pathogens that are highly contagious and resistant to treatment, such as flu viruses or tuberculosis bacteria, have the potential to spread rapidly among susceptible populations (A. C. Smith et al., 2020). Additionally, host characteristics, such as a weak immune system or high population density, may also increase the risk of transmission. The physical environment, such as poor water hygiene and sanitation, can also facilitate the spread of infectious diseases (Martin et al., 2019). Additionally, human behavior, such as international travel, close contact with animals, and unhealthy living habits, can also be a significant risk factor in the spread of infectious diseases.

Routes of transmission are another important aspect in discussing the spread of infectious diseases (Subhramanyam et al., 2019). Infectious diseases can spread through various pathways, including direct contact between individuals, air, contaminated food and drink, vectors such as mosquitoes or mice, and vertical transmission from mother to fetus. Different transmission routes have different implications for control and prevention efforts. For example, airborne diseases such as COVID-19 can spread rapidly through close contact between individuals, while foodborne illnesses can be prevented through good sanitation practices and strict food controls (T. Ahmad et al., 2021). Prevention strategies are also an integral part of discussions about the spread of infectious diseases . Prevention efforts can include a variety of measures, from vaccination and immunization, personal hygiene practices such as regular hand washing, use of personal protective equipment such as face masks, to isolation of infected patients and quarantine of affected areas (Murdoch & Detsky, 2013). Effective prevention strategies require collaboration between various parties, including government, health institutions, industry and civil society. Apart from that, prevention strategies must also be supported by education and outreach to the public about the importance of good health practices and safe behavior (Raimundo & Rosário, 2021). Responses to infectious disease outbreaks are also an important part of this discussion. When an outbreak occurs, a rapid and coordinated response is necessary to control the spread of disease and protect public health (Wójcik et al., 2014). This response includes case identification, contact tracing, isolation of infected patients, appropriate medical care, and clear and accurate public information campaigns (Leite et al., 2020). In addition, efforts to develop effective medicines and

vaccines are also an important part of the response to infectious disease outbreaks.

There are several previous research opinions. The first research according to Revolusi Industri 4.0,(2014), with the research title Industrial Revolution 4.0: Big Data, Implementation in Various Industrial Sectors (Part 2). The results of his research stated that Big data, not much different with the Internet of things (IOT), is technological concepts that are currently changing and redefining almost everything market and industry fundamentals. The second research according to Yudistira, (2021), with the research title The Role of Big Data and Deep Learning to Solve Problems Comprehensively. The results of his research stated that A capable algorithm or model is needed to understand and explore knowledge in large data sets along with a model design that automatically has the ability to predict or detect. Deep Learning with its large capacity and correlation relationships between neurons. The third research according to Priscila & Robin, (2021), with the research title Big Data Scavenging & the World of Health. The results of his research stated that this application utilizes personal data, as well as a Bluetooth network connection which functions to track location and record user activity to prevent the spread of Covid-19. This application notifies developers and users if contact with positive Covid-19 patients or Persons Under Surveillance (ODP) is detected.

The research that previous researchers have conducted is different from the research that researchers have conducted. In this research, researchers found that Big Data technology can improve predictions of the spread of infectious diseases by integrating data from various sources, including clinical, geographic, demographic and social data. Integrated Big Data systems can provide a better understanding of the factors that influence the spread of disease and enable faster and more effective decision making in responding to outbreaks.

RESEARCH METHODOLOGY

The method used in this research utilizes qualitative research methods (Gale et al., 2013). This research method is designed to investigate the role of Big Data technology in predicting and managing the spread of infectious diseases. The approach used includes literature analysis, case studies, and interviews with health experts. First, the researcher will conduct a literature analysis of recent studies that have been conducted in this field (Adunlin et al., 2015). This step in the research will involve searching and reviewing relevant scholarly articles, books, research reports, and other sources that discuss the use of Big Data technologies in predicting and managing the spread of infectious diseases (Sivarajah et al., 2017). We will identify trends, key findings, and gaps in the existing literature. Next, we will engage case studies to gain practical insights into the implementation of Big Data technologies in infectious disease outbreak prediction and management (Rachmani et al., 2023). Case studies will be selected based on the success of the implementation, the type of disease predicted or managed, the data sources used, and the impact on decision-making and intervention actions.

Data will be collected through documentation from these projects, including project reports, publications, and presentation materials (Colorafi & Evans, 2016). Case study analysis will be conducted to identify patterns of success, barriers encountered, and lessons learned for the use of Big Data technologies in the context of infectious disease spread. Finally, researchers will conduct interviews with health experts who have experience in using Big Data technologies for infectious disease prediction and management. The interviews will be conducted in person or via teleconference, and will focus on topics such as the types of data most useful in disease spread prediction, challenges faced in collecting, managing, and analyzing data, and the impact of Big Data technology implementation in public health decision-making. Data obtained from literature analysis, case studies, and interviews will be analyzed using a qualitative approach. The analysis will include identifying key findings, emerging patterns, and similarities or differences between different cases or approaches used (J. Smith & Firth, 2011). The results of the analysis will be used to formulate conclusions about the role of Big Data technologies in predicting and managing the spread of infectious diseases, as well as to identify practical implications and future research directions in this field.

This research will also address the ethical aspects of using Big Data technologies in public health. Ethical considerations include data privacy, information security, and potential bias in data collection and analysis. In interviews with healthcare professionals, they will be asked about the efforts they make to maintain the privacy and security of patient data and how they manage risks related to bias in the use of such data. In addition, the research will also consider the social and cultural context in which Big Data technologies are used for the prediction and management of the spread of infectious diseases. This includes understanding how factors such as unequal access to technology, public trust in health data, and cultural differences in health decision-making may affect the effectiveness and acceptance of Big Data technologies in different communities. This research method is expected to provide a comprehensive understanding of how Big Data technologies can be effectively used in predicting and managing the spread of infectious diseases. By utilizing a multi-source approach, researchers hope to identify best practices, key challenges, and opportunities for further development in this field.

RESULT AND DISCUSSION

The use of Big Data technologies in healthcare has become increasingly widespread in recent decades, although its main development occurred in the early 21st century. Although the concept of big data collection and analysis dates back decades, advances in computer and communication technologies, as well as the exponential growth of digital data, have enabled the utilization of Big Data in the context of healthcare to become broader and more effective. One of the key turning points in the use of Big Data in healthcare was the development of information and communication technology (ICT) in the late 20th and early 21st centuries. Advances in computerization and data processing, along with increased internet

accessibility, opened the door to the collection and analysis of health data on a larger scale than ever before. Healthcare institutions, researchers, and technology companies began to recognize the potential of Big Data to provide deeper insights into human health and the spread of disease. In the years that followed, the use of Big Data in healthcare expanded rapidly, especially with the increase in the amount of health data available. Electronic medical record (EMR) systems became more commonly used in hospitals and other healthcare facilities, resulting in large volumes of clinical data that could be used for analysis and research. In addition, the increased use of medical sensors, wearable devices, and digital health applications has also contributed to the growth of health data available for analysis.

In the mid-to-late 2000s, the private sector began to engage more actively in the development of Big Data technologies for healthcare. Major technology companies such as Google, Microsoft, and IBM began investing in projects that aimed to apply Big Data analysis in various aspects of health, including disease prediction, population management, and drug research. This opens the door for new innovations in the use of Big Data to understand, prevent, and treat diseases. In addition to technology companies, government agencies and global health organizations are also beginning to recognize the potential of Big Data in improving healthcare and addressing public health challenges. For example, the Centers for Disease Control and Prevention (CDC) in the United States has started using Big Data analysis to detect disease outbreaks faster and respond more effectively. International health organizations such as the World Health Organization (WHO) have also begun to apply Big Data technologies in their efforts to address global health issues, such as pandemic flu and other infectious diseases.In the last decade, the use of Big Data in healthcare has continued to grow at a rapid pace, driven by advances in computing technology and artificial intelligence. Increasingly sophisticated data analysis allows health professionals to gain deeper insights into diseases, their patterns of spread, and the factors that affect human health. In addition, a growing number of innovations in wearable technology, medical sensors, and the Internet of Things (IoT) are opening up new opportunities to collect real-time health data and utilize it to improve diagnosis, treatment, and disease management.

Big Data is playing an increasingly important role in addressing and understanding the spread of infectious diseases. As a large volume of data generated by various digital sources and platforms, Big Data provides researchers, health experts, and governments with a great opportunity to collect, store, and analyze relevant information related to infectious diseases. In public health, the roles of Big Data are numerous. One of the main roles of Big Data is in epidemiological monitoring. Data collected from various sources, such as hospital reports, public health surveillance data, and social media, can be used to monitor and analyze disease spread patterns in real-time or near real-time. This allows health experts to detect spikes in disease cases, identify high-risk areas, and respond quickly to prevent further spread. As such, Big Data can be a powerful tool in supporting monitoring and early detection efforts against infectious diseases. In addition, Big Data also has an important role in modeling and predicting the spread of disease. Using advanced data analysis techniques such as machine learning and data mining, researchers can identify patterns hidden in the data, including patterns of disease spread, associated risk factors, and population dynamics that influence

disease spread. By understanding these patterns, health experts can develop more accurate predictive models to forecast future outbreak events. These models can help governments and health agencies to plan timely and effective responses to infectious disease threats.

Big Data also plays a role in genomic analysis of infectious diseases. Genomic data generated from infectious disease samples can be used to better understand the genetic nature of the disease, including drug resistance and potential for cross-species spread. This genomic analysis can provide valuable insights into how infectious diseases evolve and spread among human and animal populations, and aid in the development of more effective control and treatment strategies. Furthermore, Big Data can be used to support better decision-making in outbreak management. By utilizing real-time data analysis and regularly updated predictive models, health decision-makers can gain better insights into the dynamics of disease spread, identify high risk areas, and plan optimal resource allocation for control and mitigation. As such, Big Data can help governments and health agencies to respond more effectively to infectious disease threats. Not only that, Big Data can also be used to support research and development efforts for new vaccines and medicines. By collecting and analyzing clinical data from various sources, researchers can identify potential vaccine and drug candidates for further development. This analysis can help speed up the research and development process, and enable more efficient and targeted testing in the clinical stage.

Table 1: Data Sources Used in Predicting the Spread of Infectious Diseases

NO	Data sources used	Deskriprion
1	Clinical Data	Patient medical information, including symptoms, medical history, and laboratory test results.
2	Geographic Data	Spatial data that identifies the geographic location of patients and patterns of disease spread.
3	Demographic Data	Demographic information about the population, such as age, gender and other vulnerable groups.
4	Social Data	Data relating to social factors that influence the spread of disease, such as levels of mobility and patterns of social interaction.

Table 2: Analytical Methods Used in Predicting the Spread of Infectious Diseases

NO	Analysis Method	Description
1	Statistic analysis	Use of statistical models to identify correlations and trends in disease spread data.
2	Analysis Machine Learning	Use of machine learning algorithms to predict patterns of disease spread based on historical data.
3	Social Network Analysis	Use of social network analysis to identify patterns of social interaction that have the potential to influence the spread of disease.
4	Spatial Analysis	Use of GIS techniques to map and analyze spatial patterns of disease spread.

Table 3: Prevention and Control Steps That Can Be Taken Based on Predictions of the Spread of Infectious Diseases

NO	Step	Description
1	Quarantine	Isolate infected or susceptible individuals to prevent the spread of disease.
2	Immunization	Administering vaccines to vulnerable populations to protect them from infectious diseases.
3	Community Education	Providing information about prevention methods and signs of disease to the public.
4	Health Surveillance	Carry out monitoring and early detection of new cases of infectious diseases.

Preventive and control measures that can be taken based on predictions of the spread of infectious diseases are important in dealing with public health crisis situations. Prediction of the spread of infectious diseases is a key aspect of proactive health management, enabling health care providers and governments to plan and implement timely and effective prevention and control measures. Firstly, implementing quarantine and isolation measures is a crucial step in controlling the spread of infectious diseases. Regional quarantine, patient isolation, and self-quarantine are several forms of action that can be implemented to limit disease transmission. Through regional quarantine, travel and activity restrictions can be implemented in areas with significant disease spread, thereby minimizing the risk of transmission in other areas. Patient isolation is also important to separate infected individuals from the general population, preventing further spread of the disease. Additionally, self-quarantine is an additional step that requires individuals who have been exposed or have symptoms to remain in their own homes and avoid contact with others to prevent the spread of the disease. Second, immunization is an important step in preventing infectious diseases. Mass vaccination and routine immunization programs are efforts to provide immunity to the population at large. Through vaccination, people can be given protection against certain infectious diseases, thereby reducing the risk of transmission and spread of disease in the community. Routine immunization is also important to increase individual immunity against infectious diseases, thereby minimizing the risk of infection and spread of disease in the community.

Third, public education regarding the symptoms of infectious diseases is important to help individuals recognize the early signs of infection. By knowing the possible symptoms, people will be more likely to seek medical care early and isolate themselves if necessary, thereby helping to stop the spread of the disease. Furthermore, the four, namely the importance of strengthening health system supervision, must not be ignored in dealing with the threat of infectious diseases. Increasing hospital capacity, medical equipment supplies, and training of health workers are crucial steps in dealing with infectious disease cases. By increasing hospital capacity, including additional beds and isolation facilities, the public can be guaranteed to receive the care they need in health emergencies. An adequate supply of

medical equipment, such as test kits, medicines and personal protective equipment (PPE), is also important to ensure protection for medical personnel treating patients and minimize the risk of infection. In addition, regular training for health workers on measures to prevent, treat and control infectious diseases is an important investment in preparing them to face complex health emergencies.

CONCLUSION

Based on the results and discussion above, the researcher concluded that there is a lot of feedback provided by the use of Big Data in the world of health. Many positive benefits can be felt directly. In the spread of infectious diseases, the role of Big Data technology is very significant. From risk factor analysis to prevention strategies and response to outbreaks, Big Data provides valuable and diverse insights that help health experts and policymakers face complex public health challenges. With its ability to collect, store, and analyze large volumes of data from various sources, Big Data enables the identification of disease spread patterns, predictions of future outbreaks, and the development of more effective prevention strategies. Through sophisticated data analysis, researchers can identify risk factors that influence disease spread, dominant transmission pathways, and characteristics of susceptible populations. Additionally, Big Data also enables the development of accurate prediction models to forecast outbreak events and plan timely and effective responses. Thus, Big Data technology helps increase our capacity to better manage the spread of infectious diseases, including in terms of epidemiological monitoring, evidence-based health decision making, and responsive outbreak prevention. However, challenges such as data privacy and security, integration of data from various sources, and the required analytical capacity remain issues that need to be considered in the use of Big Data in managing the spread of infectious diseases. By paying attention to these challenges and continuing to drive innovation in data analysis technologies and methodologies, we can optimize the potential of Big Data to improve public health and better respond to infectious disease threats in the future.

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