Journal of Applied Science and Advanced Technology
Journal Homepage : https://jurnal.umj.ac.id/index.php/JASAT

Alert Control Model for Exposure of COVID-19 in Industrial Closed Work Space

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ARTICLE INFO

JASAT use only:
Received date : 21 February 2023
Revised date : 16 March 2023
Accepted date : 10 April 2023

Keywords:
Labor; Industry
Alert control;
Mathematical.
Model; COVID-19

ABSTRACT

The Covid-19 pandemic has changed the industrial management system, including the regulation of labor. Most of the work in the industry cannot be done through work from home, but must still be in production units. In a number of cases, clusters of COVD 19 were found in the industry, forcing the industry to have to lock down. The problem of the lack of a model for controlling the spread of COVID 19 in the manufacturing industry is the basis for this research. The model designed in this study is also expected to be relevant in the new normal era for the manufacturing industry. The modeling and application of COVID-19 control research in the manufacturing industry is carried out through four stages, namely identification and characterization of work patterns, model design and validation, model implementation and verification, and model comparison testing. At the stage of identification and characterization of work patterns using the methods as guided by the International Labor Organization. The design phase and model validation used the Epidemic Mathematics approach and the Shewhart Control Chart. The application of the model in the industry is in accordance with the guidelines for working in a factory during the COVID-19 Pandemic according to the World Health Organization. The comparative test of the model will be processed using the diversity test. The data used is collected from the company in the form of simple tracing monitoring data for workers before entering the work area and shortly before leaving the work area, COVID 19 test data if any, employee health data, and other data if relevant to support this research. The data obtained is used for model design, both the employee health control model and the COVID-19 distribution model in the work area. The model is made with a scope that is limited only to the industrial work environment, not including outside facilities. Contamination to employees may occur when employees return home or are outside the factory. The model also does not adopt the presence of employees who are being treated for COVID-19 healing in a healing facility. In the Shewhart Control Chart model, it is hoped that a control limit can be obtained that can be used to monitor fluctuations in employee health, the diagram will be designed for daily monitoring of workers. Out-of-control data becomes a warning to carry out a reliability test (Capability) and to trace sources of contamination obtained by employees.

INTRODUCTION

The Corona Virus Disease 2019 (COVID-19) pandemic that began to spread from Wuhan, China in December 2019, is a viral pathogenic Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2)[1] The virus spread rapidly throughout the world. Until February 2021, the World Health Organization has recorded at least 113 million cases of people being tested positive for exposure and 2,527,771 people being declared dead.

The manufacturing industry is one of the activities that has a great potential to become one of the Covid-19 distribution chains, because the distribution medium is droplets. Workers who communicate with other workers in a closed system can unwittingly spread the virus either directly from person to person or through other media in the

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DOI: https://dx.doi.org/10.24853/JASAT.5.3.105-112

production system [2]. Research on mathematical models related to COVID 19 continues to be carried out with various objectives, such as to predict the rate of transmission or the rate of growth of cases in a community. Research conducted by Mohamadou et al.[3] carried out for the prediction and management of COVID 19 using the Susceptible-Exposed-Infected-Removed (SEIR) and Susceptible-infected-recovered (SIR) models based on X-ray and CT scan data.

Krishna's study of the COVID-19 spread model [4] found the reproductive value of the number of people infected by using data from the origin of the virus spread in Wuhan. Meanwhile, Anirudh [5] made a mathematical model and dynamic transformation to predict the next COVID 19 attack. Rizou et al [6]'s research made a review on food safety in the supply chain during Covid-19 in which the role of people, the food system, and the environment is a major concern. Meanwhile, Aday and Aday [7] pay special attention to food production, distribution, and demand. Research on the control model for the spread of contamination in a closed work place system of an industry has so far not been widely found. The research conducted by Serhani and Labbardi[8] was carried out in a closed system, but specifically for hospitals or homes that isolate COVID-19 patients. This condition has prompted research on the application of the COVID-19 spread control model in an industrial closed environment to be carried out. This can be done by making an application of a control model for the alert status of possible exposure to Covid 19 in an industrial closed environment. The application is made Web-based using the PHP programming language and the Laravel 8 Framework with a MySQL database.

The purpose of the study was to design and implement a model for controlling the opportunity for the spread of COVID 19 in a closed industrial environment. The targets to be achieved in this research are: a. Designing and making application of appropriate COVID 19 deployment models in industrial closed systems through available tracking data; b. Applying the COVID 19 spread model that has been compiled in one of the manufacturing industries; c. Validate the successful implementation of the COVID 19 distribution model that has been implemented in the pilot industry.

Research Urgency Until now, a number of industries, especially food, beverage and consumer goods producers, continue to produce to meet the needs of the community. Workers are arranged in such a way as to work hours and work patterns to minimize opportunities for interaction between them, making it easier to carry out contact tracing. Even if the interaction opportunities are arranged in such a way, a model is still needed to be able to read the pattern of the spread of COVID 19 in the closed system of the industry. Office clusters and industrial clusters are still considered as the source of the spread of COVD 19 in Indonesia. Meanwhile, a number of researchers have found the spread of Covid-19 along with objects that are touched by droplets, and this is a very big opportunity for the industry. Research on models for controlling the spread of COVID 19 in closed industrial cycles is very necessary to do.

EXPERIMENTAL METHOD

Thinking Framework

The design and implementation of the model for estimating the spread of COVID 19 in a closed environment of the manufacturing industry is carried out by using a combination of data information from simple tracing of employee health just before being allowed to enter the work area and shortly before leaving the work area. This data pattern is used as the basis for designing employee health control models from day to day. Contamination of employees can occur both outside and inside the industrial workplace, so tracking needs to be done at entrances and exits. The tracking uses the basis of the World Health Organization (WHO) Covid-19 Health Protocol Guidelines [16]. Conceptually, the framework of this research is shown in **Figure 1**.

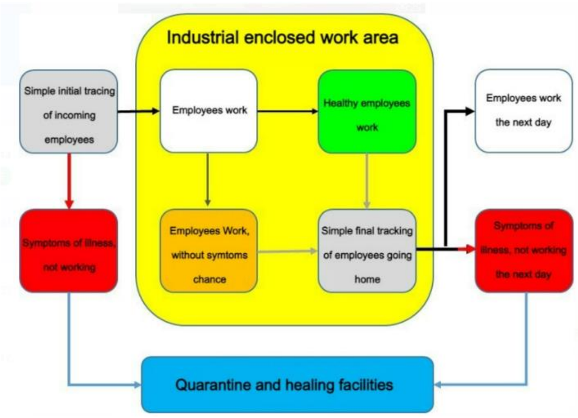

Figure 1. The framework for research design and application of the COVID-19 spread estimation model in a closed environment of the manufacturing industry

Based on this framework, the research was only conducted in the scope of the manufacturing industry work area, excluding the activities and conditions of quarantine and healing facilities. The intended quarantine and healing facilities are public facilities, not facilities provided within the company's own environment.

Stages of Work and Methodology

The methodology used in this study is secondary data collection, data analysis, model design, validation, implementation, and verification. Data collection and verification should be done virtually as much as possible, considering that the COVID-19 pandemic is not over yet. Diagrammatically, the methodology is shown in **Figure 2**.

The research plan is carried out by producers. The selection of SMEs is prioritized considering that the sanitation system and product security are not as sophisticated as large industries and are more labor-intensive. Medium cocoa processing industries use more labor [21]. The research was carried out in four stages, starting from the identification and characterization of the workforce in the industry, model design, model implementation and verification, and comparative testing. In summary, some of the methodologies used in research on the design and application of the model for estimating the spread of COVID 19 in the closed environment of the manufacturing industry.

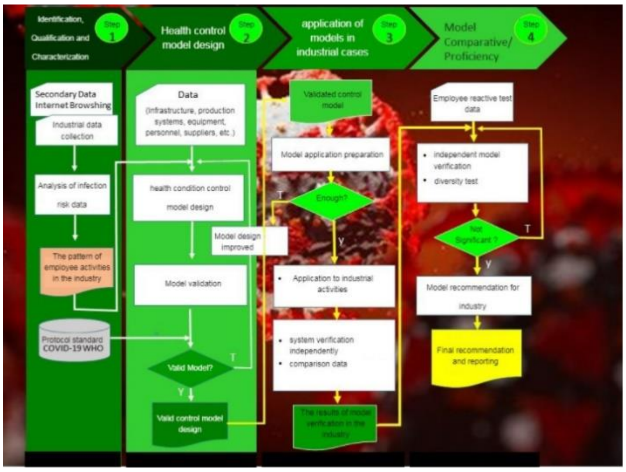

Figure 2. Methods and stages of research work on the design and application of a model for predicting the spread of COVID 19 in a closed environment of the manufacturing industry

System Development Life Cycle

System Development Life Cycle Making a status control application against possible exposure to COVID-19 in an industrial closed environment using the SDLC method as shown in **Figure 3**.

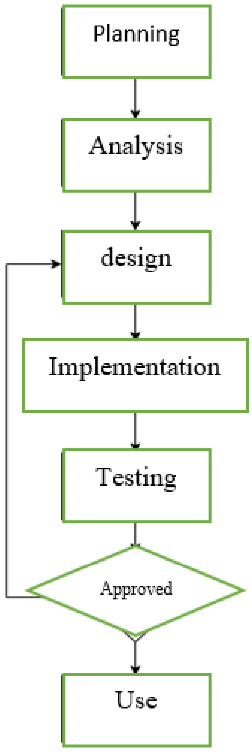

Figure 3. System Development Life Cycle (SDLC) method

Planning Stage

At this stage, the problem is defined in the temperature control system and checked for antigens where employee temperature data is entered into the database so that later it can be used.

Analysis Stage

At this stage, analysis and identification of employee temperature data is carried out as well as antigen examination.

Design Stage

At this stage, a flowchart and user interface design is carried out which will be applied according to the web-based system to be built.

Implementation Stage

This implementation stage is the stage of making the system that has been designed in the previous stage. The design of the display, program flow and database on the system is implemented into a web-based application that uses PHP and utilizes the Level 8 framework.

Trial Stage

This trial phase is carried out to determine whether the file system that has been created is running properly and functioning according to their respective functions. If the application is not functioning properly, it will return to the design stage to make improvements to the system. This testing stage is an important factor, before the system can be used by the user.

RESULTS AND DISCUSSION

Application Prototype

Prototype of status control application against possible exposure to COVID-19 in an industrial closed environment. Simplified to make it easier for admins to enter data on industrial field conditions with a front view as shown in **Figure 4**.

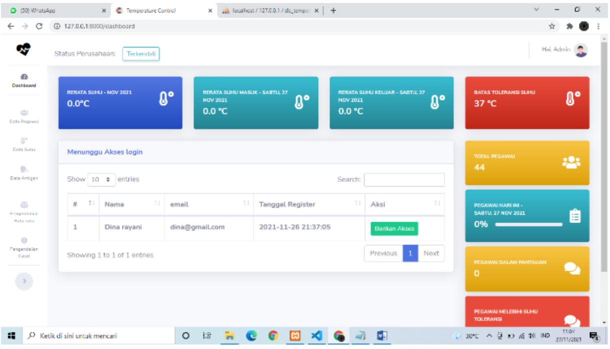

Figure 4. Dashboard Page Display

The features that are prepared are actually general for all types of manufacturing industries. Data that can be entered consists of employee data, employee temperature data, and data on antigen test results. Users can also choose which menu they want to use, where the menus provided are employee data, temperature data, antigen data, average control and defect control. To display employee data as shown in **Figure 5** which contains edit, delete and add employees. Admin can also export data if one day an employee recap is needed

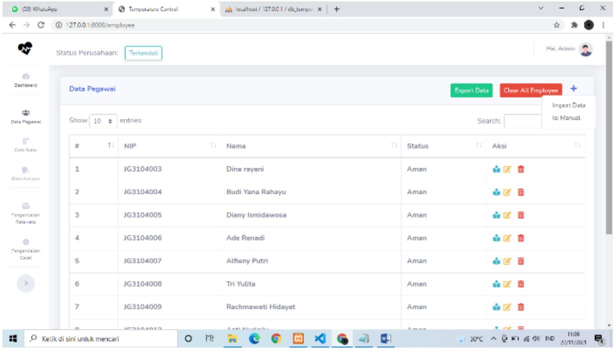

Figure 5. Display of Employee Data Pages

To display the temperature data as shown in **Figure 6**, which contains adding the inlet and outlet temperatures, or deleting temperature data. Admin can also export data if one day it is needed to recapitulation of temperature data.

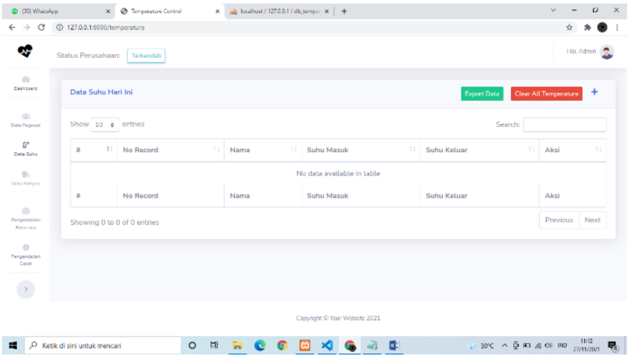

Figure 6. Daily Temperature Data Page Display

To display temperature data as shown in **Figure 7** which contains adding, changing and deleting antigen data. Admin can also export data if one day it is necessary to recap the antigen data. In this case study, there are 2 options for viewing the control chart, namely the average control chart and the defect control chart. Users can re-check before further analysis is carried out.

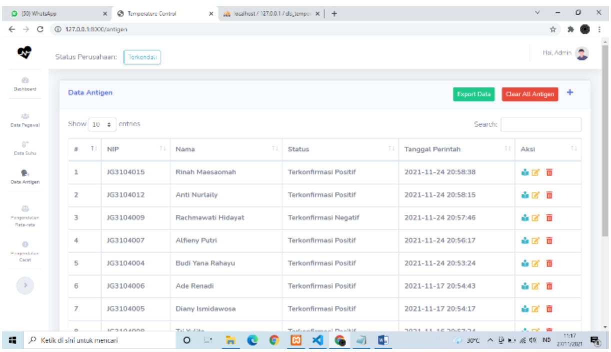

Figure 7. Antigen Data Page Display

The average control display as shown in **Figure 8** to **Figure 10** is the condition of the temperature data filter results which displays a graph of controlling the average incoming temperature in June, July and August in 2021.

Figure 8. Control Chart for June 2021 Average Entry Temperature

So, from **Figure 8** that graph in June 2021 shows that the upper limit value is 37.04°C, the lower limit is 36.26°C, and what is the middle point at 36.65°C. Overall, the movement of employee entry temperature is under control.

Figure 9. Control Chart for July 2021 Average Entry Temperature

Figure 9, for data in July 2021 shown that the upper limit value is 36.92°C, the lower limit is 36.42°C, and what is the average point at 36.67°C. Overall, the movement of the incoming employee temperature was under control only on July 12, 2021, the average temperature was rated at the lower limit with an average temperature value of 36.2°C. **Figure 10** in August 2021 shows that the upper limit value is 37.17°C, the lower limit is 36.19°C, and what is the average point at 36.68°C. Overall, the movement of employee entry temperature is under control. According to Whelan [13], the body temperature to be aware of for Covid 19 infection is 38°C.

Figure 10. Control Chart for August 2021 Average Entry Temperature

Employee temperature when leaving the workplace when returning home is also measured. This is to ensure that there is no exposure to COVID-19 for 8 hours in a closed work space in the industry. The measurement results for the June-August 2021 period are presented in **Figure 11**.

Figure 11. Graph of Controlling Average Exit Temperature for June-August 2021

Here it appears that all temperature data of working employees are still within normal limits. Of course this is not yet apparent, because according to research by Wu *et al* [14], the incubation period for the COVID 19 virus ranges from 6-9 days after infection.

CONCLUSION

Making a Model Application for Controlling the Status of Alertness to Possible Exposure to Covid 19 in an industrial closed environment can contribute to the preparedness that occurs in the Industrial Environment. Control The average temperature in and out of Industrial Employees in June-August 2021 shows the lowest temperature of 36.13^{o}C and the highest temperature of 37.14^{o}C or

36.13°C≤T≤37.14°C So that the temperature of entering and leaving employees is in a controlled range temperature recorded 36.13°C≤T≤37.14°C. So that the temperature of entering and leaving employees in. Control of defects through defective antigen tests for positive confirmation as many as 145 positive spread from January-December 2022, the most occurred in November 2022 as many as 10 people. The application is made web-based using the PHP programming language and the Laravel 8 framework with the MySQL database

ACKNOWLEDGMENT

Thank you to LPPM Universitas Pakuan Bogor forfinancial support and fellow Lecturers of Departement of Computer Science Universitas Pakuan who have provided data support for this research. And special thanks to Mufti Mahmud and the editorial team of the Journal of Applied Sciences and Advanced Technology for being willing to review our writings.

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