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AIRFLOW EVALUATION IN CLASSROOM DURING COVID-19 PANDEMIC

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ABSTRACT

The COVID-19 pandemic that hit Indonesia caused transition of the education process to online in 2020. The government seeks to improve the quality of student education in this pandemic era by preparing limited face-to-face learning. It is crucial to conduct a study on air because it is one of the mediums used to transfer viruses. This research took one sample of a classroom at SDN 27 North Pontianak. This research uses a Computational Fluid Dynamics simulation to display the air flow conditions of a room. The results showed that the fastest wind speed in the class ranged from 0.12 m/s to 0.44 m/s with green, yellow and red parameter color. The slowest wind speed was 0.01 m/s to 0.12 m/s with blue and green parameter color. The parameter shows levels are within limits suggested by ASHRAE and the effect of the availability of smooth air circulation for the classroom and stable air change. They were limiting the virus ability to spread by improving airflow. Rapid air exchange in the classroom lowers the risk of infection for students and teaching staff.

Keywords: Air flow, Computational Fluid Dynamics Simulation, classroom, COVID-19 pandemic.

INTRODUCTION

The COVID-19 pandemic is a phenomenon of coronavirus that infects humans for an extended period (Andini et al., 2022). Coronavirus can cause mild to severe flu that is detrimental to human health (Suwoso et al., 2020). The worst effect caused by being infected with coronavirus is death. However, there are still treatments for people who infected with the virus. The COVID-19 pandemic has not only disrupted health but the educational process. This pandemic has resulted in the imposition of several restrictions on school buildings. The application of these restrictions includes limiting the seating distance between students; sharing of learning sessions; reduction of learning time at school offline. These restrictions cause the learning process to be less effective. However, this restriction is an effort made to reduce the number of students infected with the virus because the virus can spread through airflow in a closed room (Nugroho et al., 2020). Openings in the room can be opened during the teaching and learning process so that the room does not store humid air and the process of air exchange occurs.

The COVID-19 pandemic that hit Indonesia caused the transition of the education process to online in 2020. The government continues strive to improve the quality of student education in this pandemic era by preparing limited face-to-face learning. However, the implementation of limited face-to-face learning has a greater risk of spreading the virus in the school environment. This virus can spread easily through indoor air. The spread of the virus through the air can be controlled from the natural ventilation system (Ratnasari & Asharhani, 2021). Natural ventilation is the process of flowing outside air into the room. Therefore, airflow is an important factor that needs to be studied to support the success of the limited face-to-face learning process.

SDN 27 North Pontianak is a public elementary school building that uses natural ventilation. Good natural ventilation will affect the smooth movement of air in the room. Natural ventilation that has two-sided and crossed openings is called cross ventilation (Nugraha, 2019). The placement of such openings makes the wind gusts felt by the people because the wind will pass through the surface of their skin. This condition makes the room not stuffy and the people do not feel hot. However, the airflow's rate of movement also affects the room's comfortable conditions. Comfort in this context means not hot and not stuffy. Comfortable conditions that are not achieved with low circulation will have an impact on indoor air pollution on the organs of the perpetrators of the activity (Candrasar & Mukono, 2013).

The classroom, a place for learning takes place, requires high concentration for students (Ratih, 2019). Classrooms that have low-pollution air circulation and wind speeds that are within the standard will support the learning process, especially during a pandemic. Prevent the spread of the virus through the air can be

done by complying with health protocols. Students and teaching staff can use masks during the learning process. However, this has an effect on the feeling of stuffiness and tightness due to masks (Samsuddin & Mardhiah, 2022). Therefore, in classrooms they can open windows during the pandemic. Classrooms must be able to ensure the effectiveness of the teaching and learning process while still paying attention to the safety of students and teaching staff. Classrooms should have a steady flow of air at all points in the space at speeds above 0.12 m/s.

The ventilation system can make efforts to improve the efficiency of airflow into the room. The natural ventilation will be more efficient and will not have a negative impact on the surrounding environment. Spaces with natural ventilation are recommended during the COVID-19 pandemic. Natural ventilation causes air to move and makes the room not humid. The high level of humidity in the room causes the virus to grow faster (Eris et al., 2020). Buildings require large airflows to control changes in temperature and high humidity in order to keep meeting room air requirements (Geetha & Verlaj, 2012). Every room has a different need for air. The amount of air required in the space is greatly influenced by the number of openings in the space. Apart from the number of openings, wind speed is an influential factor in indoor airflow (Humairoh et al., 2015). Wind speed is influenced by the surface it passes through (Simbolon & Nasution, 2017). The even distribution of the wind in the room can facilitate the flow of air in the room. Based on the discussion above, this study was conducted in order to assess the level of air flow in the classroom at the SDN 27 North Pontianak building on the teaching and learning process during the COVID-19 pandemic.

METHODOLOGY

This research intends to determine the air flow in the classroom on the supply of air circulation during the COVID-19 pandemic. Stable airflow and rate affect the effectiveness of classroom use during the teaching and learning process during the COVID-19 pandemic. The research was conducted by taking a sample of the classrooms at SDN 27 North Pontianak building. The environmental conditions of the classrooms can be seen in Figure 1. The area behind this space is planted with vegetation. However, in the front area of the room there is only a field without vegetation. Vegetation has a role in providing oxygen in the air that is inhaled by students and teaching staff. The object of research applies the space cooling technique that occurs naturally (Baharuddin et al., 2017). This area has a relatively high level of wind speed in the location around the school building.

This research collected data on March 10, 15, 17, 21, 22, 23, and 25, 2022 (Candra Monica et al., 2022). The data measurement process was carried out during March with the consideration that the culmination of the sun occurred in March at Pontianak City. This research recorded the highest and lowest wind speed levels in the 4A class. The data obtained is then entered in the value in the form of numbers into the software Computational Fluid Dynamics (CFD) Simulation to see the pattern of airflow movement. Computational Fluid Dynamics (CFD) software can display airflow data modeling by describing materials and wind speed levels using only one software (Latif et al., 2016). The simulation results are a three-dimensional model that describes the airflow with parameters of blue, green, yellow, and red colors.

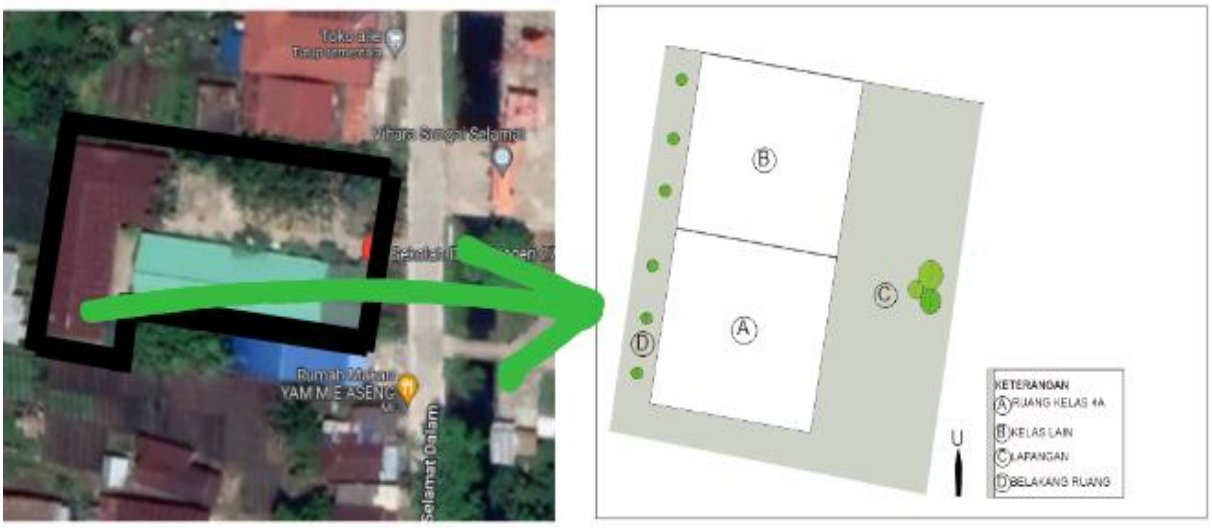

Fig. 1. Site plan Classroom 4A SDN 27 North Pontianak (Source: Candra Monica et al., 2022)

- The blue air flow parameter means a low wind speed of 0.01 m/s to 0.1 m/s.
- The green air flow parameters indicate wind speeds ranging from 0.1 m/s to 0.15 m/s.
- The yellow airflow parameters have wind speed values ranging from 0.15 m/s to 0.2 m/s.
- The airflow parameter in red means the wind speed is in the range of 0.2 m/s to 0.25 m/s.

RESULT and DISCUSSION

The wind speed measured during the research process in class 4A has a green and red parameter color with 0.11 m/s to 0.28 m/s wind speed for inlet openings. However, the average wind speed for the outlet opening is lower than the inlet opening. It's happens because the wind slows down before exiting through the outlet opening (Anisa et al., 2017). The slowdown wind can occur because before exiting through the outlet opening, the air will move through the space according to the difference air pressure in that exists at that time. Based on the results of measurements that have been carried out in the classroom, it can be seen that the air will move faster to leave the room when the value of the inlet opening wind speed is faster than the outlet opening. So, it can be concluded that the outlet opening does not affect the movement of air flow in the room (Latifah et al., 2013). However, in some cases the outlet opening can still support the air movement process by placing the position of the outlet opening that crosses the inlet opening (Dian et al., 2017). The application of these openings is called cross ventilation.

The average wind speed of outlet openings in the classroom is 0.05 m/s to 0.19 m/s with blue, green and yellow parameter color. The fastest average wind speed in the class occurred on March 21 and 22, 2022, at 0.23 m/s and 0.28 m/s. The wind speed level is affected by rainy weather with temperatures below 26˚C on that date. The average wind speed on March 10 and 15, 2022 is 0.065 m/s and 0.05 m/s, respectively. Slow wind movement conditions can be influenced by sunny and hot weather conditions (Teddy & Sawab, 2022). This is comparable to the value of the air temperature in the classroom which has a value above 27˚C at that time. Through sample measurements and comparisons with weather conditions at that time, it was seen that the movement of the indoor wind at SDN 27 North Pontianak is strongly influenced by air temperature and environmental weather conditions. Classroom conditions that have high air temperature values tend to be traversed by slow wind speeds. High wind speeds generally occur when the weather around the classroom is rainy and the air temperature is low. but there are still some conditions when the wind speed above 0,2 m/s and the air temperature value is above 27˚C.

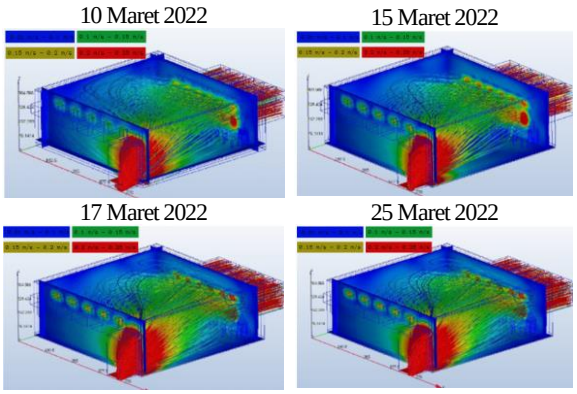

Fig. 2. Simulation of airflow in class 4A SDN 27 North Pontianak on 10 March 2022, 15 March 2022, 17 March 2022 and 25 March 2022

Based on Figure 2, it can be seen that the wind speed on different days did not change significantly. Wind speed conditions on March 10, 2022 are quite stable with speeds ranging from 0.01 m/s to 0.25 m/s or it's has all parameter color. The wind with the same speed moves in the classroom. The air flow pattern formed on this date is dominated by straight lines with wind speeds 0.12 m/s. The wind speed condition on this date is already in the zone of good air circulation due to its stable movement at high speed in the center of the space. Although there are still some spots on the edge of the classroom that have low wind speed. Wind speed conditions on March 15, 2022 are also not much different from March 10, 2022. Air moves stably from the inlet and outlet openings. The speed of air movement under these conditions ranges from 0.1 m/s to 0.15 m/s. However, the wind speed passing through the inlet opening is quite slow, which is only 0.06 m/s. This condition certainly has an impact on the slow air exchange that can occur.

The airflow pattern formed is still the same as the previous date. However, the air flow pattern with curved lines is not as much as March 10, 2022. The wind speed in the classroom is also more stable at almost all points in the room. The wind speed at that moment is 0.12 m/s. Overall, the movement of air flow in the classroom already has good air circulation and the process of changing air in the room is relatively fast with green parameter color.

Wind speed conditions on March 17, 2022 and March 25, 2022 are at the same speed. The wind speed in the classroom on that date was stable. The air flow pattern formed is a straight line from the inlet and outlet openings with a speed range of 0.12 m/s. The indoor wind speed ranges from 0.01 m/s to 0.25 m/s. A stable airflow pattern ensures the availability of clean air in the room. This condition allows the room to be used for the teaching and learning process during the

COVID-19 pandemic while still implementing strict health protocols. However, there is still a risk that the perpetrators in the room are exposed to and infected with the virus.

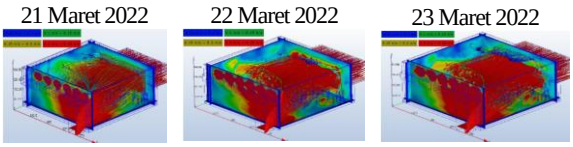

Fig. 3. Airflow simulation for class 4A SDN 27 North Pontianak on 21, 22 and 23 March 2022

Based on Figure 3, it can be seen that the average wind speed in the classroom is at a high wind speed level of 0.2 m/s with red parameter color. However, the distribution of this wind is not evenly distributed. Some points in the classroom are traversed by wind speeds below 0.2 m/s. This difference in wind speed makes the air flow pattern in one room not always the same (Budi & Sukowiyono, 2019). The air flow pattern formed at the three-time conditions is a straight-line pattern. The straight-line pattern means that the air enters through the inlet opening quickly and then exits through the outlet opening. This process can take just a matter of seconds. The pattern formed flows almost everywhere in the room at the same speed. The edge of the room has a lower airflow rate than the center point of the classroom.

The wind speed on March 21, 2022 and March 22, 2022 is not much different, only a difference of 0.04 m/s for air passing through the inlet opening. However, the wind speed on March 23 is not as stable as the wind speed on March 21, 2020 and March 22, 2022. The wind speed on March 21, 2022 is 0.1 m/s. The wind speed on March 22, 2022 ranged from 0.15 m/s to 0.25 m/s with yellow parameter color. But overall, the wind speed on that date was above 0.2 m/s, which means that it has met the standard of indoor wind speed. Conditions of wind speed in one room can indeed be different and not too evenly distributed (Naldy, 2020). This can be caused by the deflection of the wind direction by objects. Placement of the objects in an uneven space can also cause air to leave the room longer (Ashadi & Anisa, 2017). In this case, the wind speed can be adjusted based on the arrangement of the furniture.

The sample in this research has a wind speed value above 0.1 m/s. Classroom's wind speed levels are within the limits recommended by ASHRAE, which are 0.12 m/s to 0.25 m/s. The effect that arises from the value of wind speed is the availability of smooth air circulation for the classroom and stable air change. This stable wind speed of course also affects the comfort of students and teachers in the room (Sari et al., 2022). In addition to the comfort of the perpetrator, wind speed or air movement can also reduce the risk of viruses in the air surviving longer in the classroom.

Based on the explanation above, it can be concluded that wind speed can affect the spread of the virus. However, the movement of the wind can still be regulated even though using artificial ventilation. For this case, we can make a room ventilation (Sari et al., 2020). Classrooms must have ventilation that is open during the learning process so that there is a change of air in the room. Rapid air exchange in the classroom will reduce the risk of infection for students and teaching staff compared to conditions when participants are in a closed room without stable air exchange. To accelerate clean air in the room, maximizing the changing air can also be done by adding an air filter to minimize air pollution (Allen & Barn, 2020). However, the air flow in this space can still be a container for the spread of the virus because we cannot detect the presence of the virus in the air. So, it can be concluded that the overall prevention of the spread of this virus still cannot be controlled optimally. Students and teachers must still apply strict protocols if face-to-face learning is applied during the teaching and learning process (Atmojo et al., 2020). Teaching and learning activities in the classroom must also be limited to a certain period of time and apply distance restrictions between students.

CONCLUSION

The airflow in the 4A classroom at SDN 27 North Pontianak tends to be stable with the same speed for the front area of the openings, the edge of the room, and the area under the ceiling. This condition causes the formation of several airflow patterns. The airflow pattern formed during the research process is a straight-line pattern and a curved line pattern. The curved line pattern generally occurs in the area under the ceiling with low velocities ranging from 0.01 m/s to 0.08 m/s with green parameter color. A straight airflow pattern is formed when the incoming wind speed from the inlet openings has a wind sped level above 0.12 m/s. This can happen because the faster the flow of air into the room, the faster the air will come out. This condition is also supported by the placement of intersecting space openings, making it easier for incoming air to leave the room immediately. Based on the time during the research process, March 21, 2022, March 22, 2022, and March 23, 2022, had the highest velocity in the range of 0.28 m/s to 0.44 m/s with red parameter color. The late wind speed level occurred on March 10, 2022, at 0.065 m/s with blue parameter color. Based on the previous discussion, it can be concluded that the

room has the availability of clean air and fast air change. However, reducing the spread of the virus still cannot be controlled optimally through natural ventilation. Air that enters the room can still carry viruses and other harmful substances. However, the airflow in the 4A classroom at SDN 27 North Pontianak is quite effective in open conditions. Further steps can still be taken to reduce the virus's transmission in classrooms during the pandemic. Students, faculty, and other school equipment must still follow strict health regulations throughout the instructional period. Additionally, people in the room must keep a safe distance, and the division of learning sessions must be implemented while considering the classroom time limit. Airflow takes the form of a straight line under these three conditions. Air will quickly enter the space through the inlet ports and exit through the outlet openings due to the straight-line configuration. The pattern moves almost uniformly throughout the space. In the classroom, the periphery of the space has a lower airflow rate than the center. The availability of stable air change and smooth air circulation for the classroom results from air movement. The wind speed determines how quickly outside air is exchanged and replaced with fresh air.

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