Study of Indoor Health and Comfort of Classroom at Public Elementary School: Ragunan 08 Pagi

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ABSTRACT

Educational buildings are often used as places for various activities. Classrooms are often used every week for 5 days. This situation allows the transmission of disease from one individual to another, especially if classroom conditions are inadequate for health and comfort. It is important to have classrooms that are adequate in terms of health and comfort. The school that will be the object of research is SDN Ragunan 08 Pagi. The aim of this research is to understand and identify indoor health and comfort (IHC) in classrooms. This research use descriptive qualitative approach. The research results show that SDN Ragunan 08 Pagi has fulfilled 4 points out of 8 points of the overall criteria. The criteria that meet the standards are Introduction of outdoor air, control of cigarette smoke in the environment, chemical pollutants, and visual comfort.

Keywords: comfort, classroom, space, education, health

1. Introduction

Educational buildings are often used as places for various activities, especially by students and teachers. Humans generally carry out a variety of activities indoors, and children aged 6-17 years spend most of their time in educational buildings, especially at school. Classrooms are often used every week for 5 days, with usage duration of 5-8 hours per day, and can accommodate between 10 and 38 people involved in teaching and learning activities. This situation allows the transmission of disease from one individual to another, especially if classroom conditions are inadequate for health and comfort.

Success in the learning process is influenced by a number of factors. According to Hakim [1], there are two main factors that influence learning success, namely internal factors and external factors. Internal factors include the individual's own condition, such as physical and mental health, memory ability, and level of motivation. Meanwhile, external factors include environmental conditions at home, school and community, as well as everything related to that environment.

Because various factors influence the success of the learning process, it is important to have a classroom that is adequate in terms of health and comfort. Therefore, the aim of this research is to understand and identify indoor health and comfort (IHC) in classrooms. This research will focus on the classroom environment in elementary schools. The school that will be the object of research is SDN Ragunan 08 Pagi which is located in South Jakarta.

In the Technical Guide for Green Building Assessment for New Buildings (2018), greenship new building explains that the Indoor Health and Comfort (IHC) aspect consists of 8 parts, namely; Introducing of Outdoor Air, Monitoring CO2 Levels, Controlling Cigarette Smoke in the Environment, Chemical Pollutants, Views to the Outside of the Building, Visual Comfort, Thermal Comfort, Noise Levels.

2. Material and Methods

This research uses a qualitative descriptive approach, where all relevant aspects are explained and identified based on literature analysis. According to [2] qualitative observations are observations made by researchers in natural situations with the aim of exploring or revealing a meaning. During

the observation process, researchers need to record field notes both during and after observations related to significant events or phenomena in the research context and research subjects.

3. Results and Discussions

From the results of direct observations at SDN Ragunan 08 Pagi, analysis and discussion were carried out regarding the criteria that meet the requirements for Indoor Health and Comfort (IHC).

3.1 Outdoor Air Introduction

Outdoor Air Introduction can meet standard requirements by having clean and adequate air circulation, including meeting air ventilation requirements. In accordance with the GBCI Technical Guide: Green Building Assessment for New Buildings version 1.2 [3], the aim of the introduction of outside air is to maintain and improve indoor air quality, in accordance with the ventilation requirements necessary for the health of building users, with reference to the standards set established by Ashrae 62.1-2007.

$$Vbz = Rp.Pz + Ra.Az$$

Vbz is the external air flow design required in the breathing zone, Rp is the external air flow rate required per person according to Ashrae standard 62.1-2007, Pz is the zone population, Ra is the external air flow rate required per unit area , and Az is the area of the conditioned floor zone. By substituting the values given, the outside air flow rate in the classroom at SDN Ragunan 08 Pagi can be calculated:

Rp : 5 L/s•person (according to Ashrae Standard 62.1-2007)
Pz : 31 people (30 students + 1 teacher)
Ra : 0,6 L/s•m2 (according to Ashrae Standard 62.1-2007)
Az : 65,25m2 (7,5m x 8,3m)

Vbz = (5.31) + (0,6.65,25)
Vbz = 155 + 39,15
Vbz = 194,15 L/s
Vbz per person = 6,3 L/s/person

The results show that the required external air flow in the breathing zone is 194.15 liters per second, equivalent to 6.3 liters per second per person. This provides information that the indoor air flow meets the Ashrae 62.1-2007 standards and obtains criteria points, which are appropriate in the design of educational buildings. This is caused by air circulation that occurs through ventilation or openings available in the classroom.

3.2 Monitoring CO2 Levels

Carbon dioxide (CO2) plays an important role in indoor health and comfort. SDN Ragunan 08 Pagi in the 3d classroom on the 2nd floor has a size of 7.5m x 8.3m with an average number of students between 28-32 people per class. The standard for good residential density according to the Indonesian Ministry of Health (2017) is 2 people per 8 m². With a total of 32 students plus teachers, the appropriate classroom space is 128m2. However, the 3D classroom only has a size of 62.25m2. This does not meet the standards for good residential density according to the Indonesian Ministry of Health 2017. The reason is that the classroom is not large enough for the size of the room's users. Therefore, it does not get points for the CO2 Level Monitoring criteria.

Source: Personal Data, 2023
Figure 1: Classroom Plan

3.3 Control of cigarette smoke in the environment

Cigarette smoke has the potential to be detrimental to your own health and that of others because it contains dangerous substances such as nicotine and the smoke can cause a fire risk if thrown away carelessly with the fire still burning. In accordance with the provisions of Minister of Education and Culture Regulation No. 64 of 2015 concerning Non-Smoking Areas in School Environments, parties including school principals, teachers, educational staff, students and other individuals are prohibited from smoking, producing, selling, advertising or promoting cigarettes around the school environment.

Source: Personal Data, 2023
Figure 2: No smoking stickers in the school environment

Based on provisions that require signs prohibiting smoking, SDN Ragunan 08 Pagi already has signs prohibiting smoking in the school environment. This is useful for providing information that smoking is not permitted around the school area. Therefore, points are earned for this criterion.

3.3 Chemical Pollutants

This requirement requires the use of chemicals that are environmentally friendly and safe for the user's health. In the Greenship Interior Space guide version 1 (2012), it is explained that for chemical pollutants, evaluation must be carried out on VOC, formaldehyde and asbestos levels. At least 75% of the total ceiling, walls and furniture, as well as all floor materials, must be made from materials with low VOC and formaldehyde levels.

The wall materials in the construction of SDN Ragunan 08 Pagi use blesscon lightweight bricks, which have been certified by SNI 8640:2018 and Green Label Indonesia to ensure environmental and user safety. The process of installing light bricks uses T-30 white cement mortar with a low pH to protect the paint color. The wall paint used, Mowilex Emulsion VIP interior and Mowilex weathercoat exterior, has low VOC levels, is Green Label Indonesia certified, and is safe for the environment and user health because it has ultra-low VOC.

Source: Mowilex.com, 2023
Figure 3: Wall paint used

The floor uses ceramic which does not absorb volatile organic compounds and other contaminants. Demix C1 adhesive used for ceramics complies with European Standard EN 12004:2001. Door and window frames use aluminum, an environmentally friendly metal that is light, durable, and 100% recyclable and corrosion resistant. Chairs and tables use Solid Laminated Board (SLB) material with a spray finish and an iron frame finished with Powder Coating without VOC. The ISO 14001 environmentally friendly label has been given to these chairs and tables according to the e-catalog of the Government Goods/Services Procurement Policy Institute (LKPP). The connecting doors between classes are made of double plywood with natural gypsum which is VOC free.

Source: Personal Data, 2023
Figure 4: Tables and Chairs in the Classroom at SDN Ragunan 08 Pagi

Classrooms use gypsum ceilings and plywood doors with natural gypsum, which are considered environmentally friendly because they are energy efficient, do not produce waste, are able to reduce heat to save electricity, and can be recycled. Gypsum is also free from abscesses, making it safe for the surrounding environment.

Source: Personal Data, 2023
Figure 5: Classroom door frame and door

The lamp is a tube lamp from the Philips essential LED tube brand, which consumes less than half the energy of a regular fluorescent lamp, does not contain mercury and the tube is not made of glass, so it is safe for the environment. All table, chair, door and wall paint materials meet chemical pollutant standards, so they get points for the Chemical Pollutant criteria.

3.4 View to the outdoor

The exterior view criteria aim to reduce eye fatigue by providing long distance views through visuals connected to the outside, thereby improving eye comfort. According to the Indonesian Green Building for new buildings version 1.1 (2015), the standard for meeting the criteria for views to the outside of the building is if 75% of the net rentable area (NLA) has a direct view to the outside which is limited by transparent openings when a straight line is drawn.

Source: Personal Data, 2023
Figure 6: Cutouts and details of windows in the classroom

The percentage calculation results from the total wall area of 69.57m² and the total window area of 13.86m² only reached 20%. This is caused by the presence of windows that offer limited views and are only on one side of the room, so that the NLA percentage does not reach the set standards. Therefore, no points are awarded for the Exterior View of the building criterion.

3.5 Visual Comfort

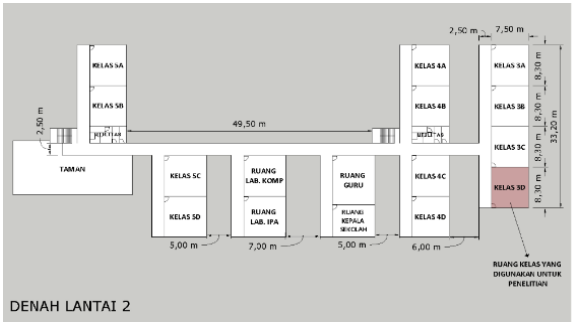
This criterion aims to ensure that the classroom can be seen visually comfortably with the lighting in the classroom, both natural lighting and artificial lighting. Visual comfort standards aim to ensure appropriate lighting in the room with the aim of increasing the productivity and comfort of the occupants [4].

Source: Personal Data, 2023
Figure 7: Classroom View

The standard applied for this criterion is SNI 03-6575-2001 which stipulates that classrooms must have lighting of at least 250 Lux. Observations were carried out at 12.00 WIB and 15.00 WIB, with measured lighting results of 514 Lux and 476 Lux respectively. From the results of these observations, it can be concluded that the classroom lighting has met the set standards, namely exceeding 250 Lux. This is because a lot of light comes in from the large windows. This class gets visual comfort criteria points.

3.6 Thermal Comfort

Comfort is felt when the body reaches thermal balance where the body's heat production is balanced with heat release and heat absorption from the environment. Air speed also plays a role in thermal comfort, which can be calculated based on daily, weekly and monthly averages to determine a mean value [5].



Source: Personal Data, 2023
Figure 7: Second Floor of School Plan

Thermal comfort is measured according to the SNI 03-6390-2011 standard, which specifies a room temperature range of 24°C to 27°C with 60% humidity. The results of observations were made to measure temperature and humidity in the classrooms at SDN Ragunan 08 Pagi. Thermal comfort could be shown at Table 1. Analysis of thermal comfort criteria.

Table 1: Analysis of thermal comfort criteria

Sample	Air Temperature (°C)	Air Humidity (%)	Analysis
Classroom when windows were closed	30,8	48,3	Deviates from the expected standard
Classroom when the window was opened and the fan was turned on	26,4	55,2	Deviates from the expected standard
Outside the classroom	27,7	56,2	Deviates from the expected standard

Source: Analysis Data, 2023

All samples do not meet air humidity standards above 60% according to SNI 03-6390-2011. However, the air temperature, the temperature in the classroom, when the windows are open and the fan is on, is in accordance with the standards. This is caused by outside winds and fans which can reduce the temperature. However, because the room is behind another school and is not exposed to sufficient outdoor vegetation, as well as the placement of the classroom close to a dividing wall, the air humidity is below standard. So this research did not get points for the Thermal Comfort criteria.

3.7 Noise Level

This criterion is measured to determine whether the level of disturbance in the classroom and surroundings can result in disruption or not. The standard used as a reference is the SNI 03-6386-2000 standard, which stipulates that the optimal level of interference in the classroom is 35 dBA, with a maximum limit of 40 dBA.

Based on measurements, the interference level in the second floor classrooms facing other buildings reached 47.7 dBA, exceeding the SNI 03-6386-2000 standard which sets a good interference level between 35 to a maximum of 40 dBA. Therefore, the room does not meet the Noise Level criteria and does not receive points.

3.8 Final Analysis Results

Ensuring indoor health and comfort involves a combination of design, maintenance, and behavioral practices. Building design should prioritize ventilation systems, insulation, and materials that promote air quality and thermal comfort. Regular maintenance of HVAC systems and cleaning to reduce indoor pollutants is essential. Additionally, occupants can contribute by avoiding smoking indoors, using environmentally friendly cleaning products, and practicing good ventilation habits. Ultimately, a healthy and comfortable indoor environment supports overall well-being and productivity.

From the criteria provided, there are several items that meet the standards and several other items that do not meet the standards. The following is an explanation for each criterion:

- Outside Air Introduction: Has an air flow of 6.3 L/s per person which is according to standards, so it meets the criteria.
- CO2 Monitoring: Does not have measurements that comply with standards, so it does not meet the criteria. CO2 monitoring is necessary to measure indoor air quality and ensure comfort and health levels.
- Controlling Cigarette Smoke in the Environment: Have a no-smoking sticker in the school parking lot, so that it meets the criteria. This step is important to ensure the environment is free from cigarette smoke which has the potential to be detrimental to health.
- Chemical Pollutants: Has materials that are low in VOCs and other harmless chemicals, so they meet the criteria. This is important to reduce exposure to chemical pollutants that can harm health.
- View to the outside of the building: Does not meet the NLA (Net Lettable Area) percentage size above 70%, so it does not meet the criteria. The view outside the building can provide psychological benefits and well-being for residents, therefore it is important to maximize the view outside the building.
- Visual Comfort: Has lighting that is comfortable when viewed visually, so it meets the criteria.
- Thermal Comfort: Does not have comfort in air humidity, so it does not meet the criteria. Thermal comfort includes appropriate control of air temperature and humidity to ensure comfort for occupants.
- Noise Level: Does not have low noise, so does not meet the criteria. High noise can disturb occupants' comfort and concentration, therefore it is important to control noise levels.

There are total of 8 criteria but only 4 that meet the standards. This shows that there are several aspects that need to be repaired or improved to achieve health and comfort standards in this environment. It is shown by Table 2. Final Analysis Result.

Table 2. Final Analysist Result

No.	Criteria	×/✓	Info.
1.	Outdoor air introduction	✓	Has an air flow of 6.3 L/s. Person who meets standards
2.	CO2 monitoring	×	The CO2 monitoring does not meet the standards for appropriate measurements.
3.	Controlling cigarette smoke around the area	✓	The school has no smoking stickers in the school parking lot
4.	Chemical Pollutants	✓	Has materials that are low in VOCs and other harmless chemicals
5.	View to the outside of the building	×	Does not have an NLA percentage size above 70%
6.	Visual Comfort	✓	Has comfortable lighting when viewed visually
7.	Thermal Comfort	×	The humidity levels do not meet the standard requirements
8.	Noise Level	×	Does not have low noise
Total =		4	

Source: Personal Data, 2023

Based on the final results of the analysis, the 3d classroom on the 2nd floor of SDN Ragunan 08 Pagi received half of the total criteria, the points that did not meet the criteria were CO2 Level Monitoring, View to the Outside of the Building, Thermal Comfort and Noise Level. When monitoring CO2 levels, the room size that meets the standards must be 128m2 or more, while the 3D classroom only has a size of 62.25m2, which is still very far from the existing standards. Then the criteria for views outside the building must have an NLA with a percentage of 70% or more, while the 3D classroom only has an NLA percentage of 20%. This is caused by the windows which are only on one side of the wall so the view is very minimal. However, this does not mean that classroom lighting is below standard. As with the visual comfort criteria, the size of light entering the room at 12.00 WIB is 514 Lux and at 15.00 WIB the size of light entering is 476 Lux. This is in accordance with the SNI 03-6575-2001 standard. Apart from that, regarding thermal comfort, the air temperature is up to standard but the humidity is still below standard, this is caused by the condition of the room which is located at the back of another school without adequate outdoor vegetation, and the position of the classroom close to the wall creates humidity. air becomes below standard. And in terms of noise level criteria, the noise measurement results are still below standard because SDN Ragunan 08 Pagi is close to another school and close to a petrol station so vehicle noise will be more audible.

4. Conclusion

So it can be concluded that SDN Ragunan 08 Pagi has fulfilled 4 points out of 8 points of the overall criteria. The criteria that meet the standards are Introduction of Outside Air, Control of Cigarette Smoke in the Environment, Chemical Pollutants, and Visual Comfort. So the results of this research are that classrooms, especially class 3d on the 2nd floor at SDN Ragunan 08 Pagi lack good health and comfort. All comfort and health criteria in this classroom are influenced by several factors, such as adequate lighting, monitoring CO2 levels with ventilation or openings in the room. Healthy interior materials and arrangement, temperature and humidity, and acoustics that keep the sound comfortable to hear.

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