Microbiology Factor Measurement as Indoor Air Quality Parameter in Public Space

Oktofa Setia Pamungkas[1)], Henny Ayu Nirwala[2)], Dina Mala Pardede[3)]
[1, 2, 3)] Occupational Health and Safety Office (BK3) Samarinda
email: oktofa.sp@gmail.com

Abstract

Nearly 90% of people spend their time in both private and public indoor spaces. Bank is one of the public indoor spaces accessible to the community, as well as a place for some workers spending time every day. This study was conducted in 6 banking sectors in Samarinda, East Kalimantan, focusing on the existence of microorganisms such as bacteria and fungi/mold. The purpose was to investigate the number of microorganisms, both bacteria and fungi, contained in indoor areas of several bank offices in Samarinda. The results showed that the number of bacteria and fungi at several sampling points in 6 offices were above the standard of Permenaker RI No. 5 the year of 2018 and Permenkes RI No. 48 the year of 2016, i.e.,>700 cfu/m3 for bacteria and >1000 cfu/m3 for fungi.

Keywords: Microbiology Factor, Indoor Air Quality, Public Spaces.

1. INTRODUCTION

Human spends nearly 90% of their time in private as well as public indoors such as houses, gyms, schools, public transportations, and banks (Cincinelli and Martellini (2017). This condition makes the community easier to expose to several indoor hazards. An indoor environment (bioaerosol) can affect human health and physical conditions (Dacarro, 2005). Indoor air quality is known to determine the quality of public health (Jantunen et al., 2011). Previous researches prove that problems with indoor environmental quality such as thermal, acoustic, visual, and air quality of a building have a direct effect on the comfort, health, and productivity of the occupants (Wulandari, 2013; Abdullah dan Hakim, 2011; Wismana, 2016). Indoor microenvironment has unique characteristics, which are determined by local outdoor air, specific characteristics of buildings, and indoor activities (De Giuli et al., 2012; Pegas et al., 2012; Spring et al., 2011).

Indoor air quality refers to the quality of air in and around buildings, especially those relating to the health and comfort of a building's occupants (EPA, 2019). Research conducted in the last 20 years by the United States Environmental Protection Agency found that indoor air is often more polluted than outside air, and indoor air pollution has been ranked among the five top risks to public health (Gawrońska and Bakera, 2015). Building materials and coatings, carpets, furniture, liquids and cleaning products, cigarettes, air cooling systems, copiers, markers, and other materials are some of the sources of indoor air quality problems (Tamburrano et al., 2017). The source of indoor air quality problems can also come from microorganisms present in the air, including bacteria, fungi, and viruses (Gocgeldi et al., 2011).

Indoor air quality becomes a serious discussion because humans spend most of their time indoors (Zhang and Smith, 2003). One of the indoor spaces is a bank. Bank is one of the legal entities engaged in financial services and one of the most important public indoor spaces (Paparang, 2016). Therefore, the air quality inside the banks must be optimal, both in the term of environmental factors and in the amount of microbial contamination.

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Microbial air qualities are an important consideration when one is designing an indoor workplace to provide a safe and comfortable work environment. The purpose of this research is to investigate the number of microorganisms, bacteria and fungi, in indoor air space in several bank offices in Samarinda, East Kalimantan.

2. RESEARCH METHOD

The focus of this study was to collect data of bacteria and fungi in several indoor spaces of bank offices in Samarinda, East Kalimantan. Additional data obtained from the measurement of relevant physical factors include air temperature, humidity, and wind speed. The study was conducted in 6 banking offices. The data measurement was carried out in three rooms of each office, i.e., service room, employee room, and office hall. The method used to trap microbes was agar filter using QuickTake ® 30 vacuum pump with constant flow at 20 L/mins and run for 5 minutes for each room. The incubation and determination were carried out in laboratory.

3. RESULTS AND DISCUSSION

The measurement result of microbial counts and physical factors is presented in Table 1:

Table 1. Result of microbial counts and physical factors measurement

Sampling Point	**Location**	**Parameters**		**Environmental Data**		
		Bacteria (cfu/m^3)	**Mould (cfu/m^3)**	**Temp. (ºC)**	**RH (%)**	**Wind (m/s)**
Service Room	Location 1	900 *	250	21.6	57.1	0.0-0.13
	Location 2	1180 *	160	24.2	57.6	0.0-0.28
	Location 3	890 *	170	25.5	60.2	0.10-0.60
	Location 4	710 *	130	23.1	70.7	0
	Location 5	2250 *	725	24.0	49.5	0.0-0.03
	Location 6	1210 *	630	29.1	59.7	0.18-0.30
Room Staff/ Employees	Location 1	150	100	26.1	55.2	0.0-0.02
	Location 2	1610 *	50	23.8	56.8	0.0-0.12
	Location 3	590	140	25.3	64.0	0.20 to 0.30
	Location 4	1300 *	230	24.0	62.5	0
	Location 5	1400 *	1825 *	25.3	64.0	0.0-0.12
	Location 6	1630 *	520	24.2	75.4	0.03-0.31
Hall	Location 1	325	175	21.6	58.7	0.0-0.06
	Location 2	1190 *	150	23.3	58.3	0.0-0.19
	Location 3	-	-	-	-	-
	Location 4	-	-	-	-	-
	Location 5	-	-	-	-	-
	Location 6	860 *	250	24.5	67.0	0.0-0.17
Description	* = Exceed Standard					
Standard: Permenaker RI No. 5-year 2018		**< 700**	**< 1000**	-	-	-
Permenkes No. 48 Year 2016		**< 700**	**< 1000**	**23-26**	**40 - 60**	**0.15-0.5**

It can be inferred from the table that the service room of all sample locations showing bacterial numbers that exceed the standard from The Ministry of Labor and Ministry of Health. As for the employee room, four out of six bank offices have high number of bacteria. While for the office hall, only two locations show high numbers of bacteria. Information on microbial concentrations (bacteria and fungi) is necessary to estimate health hazards as well as to create a standard of indoor air quality

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control (Hayleeyesus and Melaku, 2014).

Air quality in a room is influenced by biological factors (known as Bioaerosols) and physical factors. Bioaerosols are various particles in the air with biological origins. Bioaerosols can consist of viruses, bacteria, fungi, algae, pollen plants, metabolites, endotoxin, mycotoxin, glucan, and fragments of organic matter (Moldoveanu, 2015). Sturm (2016) states bioaerosol can be harmful to human in a certain concentration. The presence of bioaerosols can be associated with human diseases, such as pneumonia, influenza, measles, asthma, allergies, and digestive disorders (Srikanth et al., 2008).

There are eight (8) main sources of indoor microbes that include pets, plants, plumbing systems, heating systems, ventilation, air conditioning, dust suspenders, and outside environments (Prusin and Marr, 2015). Ecological factors affect the development and dissemination of indoor microbes. Ecological factors affecting the presence of indoor microbes include temperature, humidity, lighting, room size, room cleanliness, and ventilation (Dedesko et al., 2015; Purnamasari et al., 2017).

The physical factors measurement result indicates that several sampling points have not fulfilled the minimum-maximum standard of physical environmental conditions according to PERMENKES No. 48, the year of 2016, on the minimum requirements of air quality in an office room. The standard value for temperature ranges from 23 – 26 °c, while for humidity ranging between 40 – 60%. Temperature and humidity have a high correlation to the existence of microorganisms. The low temperature will result in high humidity. High humidity can protect the microorganisms from the inactivation of UV so that in the condition of high humidity levels of indoor six will also be higher (Niazi et al., 2015).

Sampling point that does not meet the minimum-maximum standard of physical condition for the workspace, including the service room at the location 4 with a humidity of 70.7%, the service room in the location 6 that has a temperature of up to 29,1 ° C, employee room in location 3 and 5 which has a humidity number reaches 64.0%, employee room at location 4 has humidity 62.5%, even room staff/employees at location 6 based on the data in Table 1 has a humidity rate up to 75.4%.

The presence of bacteria is partly determined by temperature. A study conducted by Naddafi (2011) found that the temperature was positively correlated to the presence of bacteria. Bragoszewska (2017) displays that indoor bacteria may develop at temperatures ranging from 8°C to 27°C. In line with Bragoszewska, Lal (2017) reveals that bacteria can live well at a temperature of 26°C to 30,8°C. The temperature at each sampling point of 6 locations ranges from 21.6°C to 29,1°C, making the points sampling from each location a good place for bacterial development.

Meanwhile, the value of relatively good humidity for bacterial growth is >50% (Verdier et al., 2014). Abdullah and Hakim (2011) found the indoor humidity is directly related to the total number of germs in the air. Based on the data, three points sampling across locations have a humidity rate of >50%, which makes 3 point sampling on six research sites, a good place for bacterial growth.

As for fungal counts in this study was in line with Heikkinen (2005) and Bosshard (2011). Optimum growth of fungi obtained on temperature ranges

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from 25-30°C, while moisture ranges from 60%-70%. Based on data, the average temperature and moisture in 3 point sampling on each location show below optimum for fungal growth. However, there is one point sampling of the fifth location with a high number of fungi (1825 cfu/m3 or above the standard). This condition is confirmed by the temperature and humidity of the room, which suitable for fungal growth.

The growth of microorganisms, both fungi and bacteria, in addition to being affected by temperature and humidity, is also affected by wind speed. Wind may increase the concentration of microbes in the air, but on the other hand, it can reduce the concentration of airborne microbes (Burrows et al., 2009). The wind can increase the microbial concentration at low speed, i.e., < 4 m/s, meanwhile if it is in high speed > 4 m/s, it reduces the concentration of microbes (Dueker et al., 2017). This condition is also a factor of the high concentration of microbes at 3 point sampling in 6 locations of the study. Table 1 shows that the wind speed was very low, it is even barely present. This condition results in non-air circulation in the space, so the microbes tend to settle.

Another factor that affects the microbial concentration in the air is human activities (Lax et al.,. 2014; Bhangar et al.,. 2016). A human being can donate as many as 0.9 million biological aerosol particles per hour. An increase in the number of biological aerosol particles occurs from 5 to 69 million particles when humans walk or move their upper body. Conditions of sampling point with high human activities explain the high levels of microorganisms.

Indoor air quality has a direct correlation with air ventilation conditions. The data listed in Table 1 indicates that the bacteria at all sampling points has a very high number. This condition signifies less good air ventilation at each sampling point throughout the research site.

Canha (2015) suggests the level of indoor bacteria can be associated with insufficient occupancy and ventilation. A similar study by Leung (2015) found that air pollutants being transported in and out of residence depend on ventilation and infiltration. Opening windows frequently will be the right solution to this problem (Kalogerakis, 2005).

4. CONCLUSION

The existence of good microbial bacteria and fungi in this research still exceeds the maximum standard stipulated in the 2018 Permenaker RI No. 5 and the 2016 Permenkes RI No. 48. This condition is supported by physical environmental factors that include temperature, humidity, and wind speed at the research site that supports the growth of bacteria and fungi.

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