International Journal of Mechanical Engineering (IJME)
ISSN(P): 2319-2240; ISSN(E): 2319-2259
Vol. 3, Issue 1, Jan 2014, 47-52

International Academy of Science, Engineering and Technology
Connecting Researchers; Nurturing Innovations

MONITORING OF THE INDOOR AIR QUALITY PARAMETERS IN THE DAY-CARE CENTRES IN TROPICAL COUNTRY

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ABSTRACT

Indoor air quality monitoring in various public premises such as school, day-care centre, office and industrial factory buildings has attracting many scientist, researchers as well as academicians. Since most people spends their daily activity outside their house, poor indoor air quality in all sort of location of public places can be related with their health and life comfort as human beings. This paper involved in monitoring the indoor air quality in two location of day-care centre. First location is Federal Territory of Kuala Lumpur, being the capital city of Malaysia. Second location is Selangor, which could be categories as suburban area. Temperature, humidity, air velocity, particulate matter (PM_{10}), carbon monoxide (CO) and carbon dioxide (CO_2) were measured as the parameters of indoor air quality in this study. Total 30 day-care centres in Kuala Lumpur and Selangor were selected for this study. The monitoring was conducted during the day-care centre operating hours from 9am to 5pm (8hours) using IAQ meter TSI 8762 for measurement of temperature, humidity, CO and CO_2, Dust Trak TSI 8520 for the measurement of PM_{10} and VeloCalc TSI 9555 for the measurement of air velocity. The CO, CO_2 and PM_{10} levels indicated that the city of Kuala Lumpur has higher pollutant levels than suburban area or Selangor.

KEYWORDS: Air Pollutants, Day, Care Centre, Indoor Air Quality, Particulate Matter

INTRODUCTION

Environmental quality is defined as the harmony of thermal, acoustic and luminous factors along with the air that is breathed, which should not be a danger for proper health, and the air should be fresh (Fernandeza *et al*., 2013). Good indoor air quality (IAQ) is desired for a healthy indoor environment. Air quality depends on the strength of indoor and outdoor air pollution sources. The physical indoor environment is identified as a resultant of air quality with perceived temperature, noise and light. Since children are more vulnerable than adults to potential health problems from environmental exposures, special attention needs to be given to the public premise for children. Therefore it is important to ensure a healthy indoor environment at children premises such as schools and day-care centre (Awbi, 2003).

In developing countries, school and day-care centre provide major environment for the children since they spend a considerable part of their time at school for around 8-10 hours a day and 40-50 hours a week (Gupta *et al*., 2010). Indoor environmental quality can contribute a significant influence on the student attendance and performance. Studies have proven that poor indoor air quality in a school premise might result in more illness, absenteeism and asthma attacks on children (Kamaruzzaman *et al*., 2013). Studies which were done in United States has indicated that good air quality in schools have enhanced the attendance intensity of the students and reduced the health problems among those young occupants of the school (Mendell *et al*., 2005).

This paper is focused on the day-care centre attendees who were consisted of small children under 6 years of age that are more prone to illness. Negligence or failure to prevent this problem can result in discomfort for the children and possible health problem (Schwartz, 2004). The aim of this study was to gather information on the indoor environment of day-care centre premise in order to determine the value of each IAQ parameters in different location of selected day-care centre and comparing the result to the Code of practice on Indoor Air Quality standard of Department of Occupational Safety and Health (DOSH, 2010).

METHODOLOGY

The data collection for IAQ parameters was measured beginning from March to October 2010 in 15 selected day-care centre premises in Federal Territory of Kuala Lumpur and 15 selected day-care centres in Selangor. The day-care centre premises in Kuala Lumpur were located in the bustling city area while the day-care centre premises in Selangor were located in the suburban area. Written consent has been granted from the day-care centre authorities before pursuing with data collection. The entire day-care centre premises have similar building characteristics, number of occupants, daily activities and equipped with air conditioning system. The data monitoring were conducted for the duration of ten days for each day-care centre.

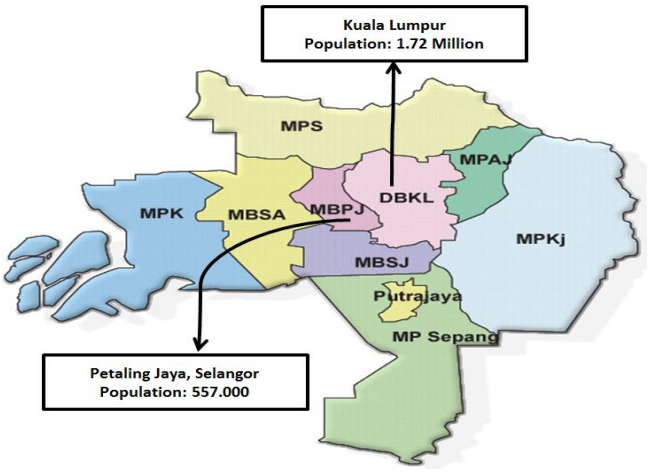


Figure 1: Map of Kuala Lumpur and Selangor Areas

Data Sampling

The data sampling was generated during the day-care centre operating hours (9am-5pm) when the room was mostly occupied which following ASHRAE procedure for acceptable ventilation for acceptable indoor air quality (ASHRAE Standard 62-2001). The sampling devices were placed on the top of a table within children breathing zone (0.5-0.7 m) off the ground level, out of the children's reach and away from the doors and windows.

Instrument Selection for Data Collection

IAQ meter TSI 8762 was utilised for the measurement of temperature, humidity, CO and CO_2 while Dust Trak TSI 8520 and VeloCalc TSI 9555 was employed for the measurement of PM_{10} and air velocity respectively. Prior to the data collection, outdoor air measurement was collected as a reference. Temperature, air velocity, CO and CO_2 were recorded every 5 minutes while PM_{10} was taken on the 10 minutes interval.

Data Analysis

All the data collected were analysed using SPSS version 20 statistical package. The collected data was entered into spreadsheet of SPSS for the analysis. Single classification analysis of variance (ANOVA) was performed when the

normality and homogeneity of the data has been confirmed. The Statistical result of $p \leq .05$ represents the significance of data.

RESULTS AND DISCUSSIONS

Table 1 shows the comparison of indoor air parameter in two different location of day-care centre. The data was analysed using one-way ANOVA and T-test to determine the significance of the result. The different value of temperature, relative humidity (RH), PM_{10}, CO and CO_2 are statistically significant ($p \leq .05$) whereas the result for air velocity value shows that the difference is not statistically significant ($p > .05$).

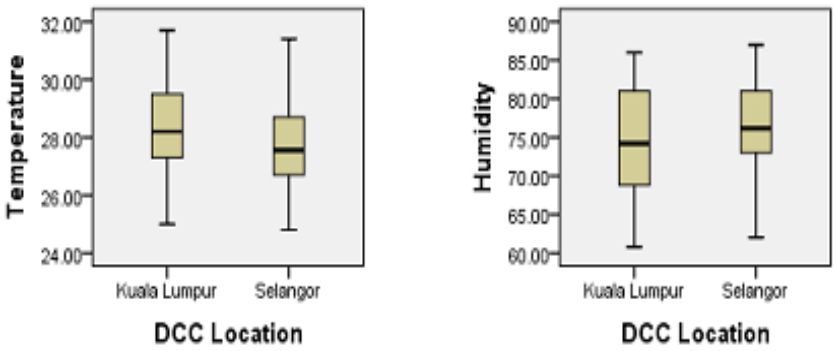
Table 1: Comparison of Indoor Air Parameter Level in the Day-Care Centres Using T-Test

Name	DCC Location	N	Median	Range	S.D	p-Value
T (°C)	KL	15	28.28	25.00-31.70	1.49	.001*
	SL	15	27.50	24.80-31.40	1.41	
RH (%)	KL	15	74.20	60.80-86.00	6.82	.013*
	SL	15	76.15	62.00-87.00	5.76	
Air velocity (m/s)	KL	15	0.14	0.8-0.18	0.02	.570
	SL	15	0.13	0.8-0.19	0.02	
PM_{10} ($\mu g.m^{-3}$)	KL	15	70.10	58.60-80.70	4.59	<.001*
	SL	15	67.60	58.30-78.00	4.45	
CO (ppm)	KL	15	3.20	1.90-4.40	0.60	.002*
	SL	15	2.90	1.60-4.00	0.58	
CO_2 (ppm)	KL	15	771	629-878	63.16	<.001*
	SL	15	745	587-849	66.36	

$p \leq .05$

Temperature, Relative Humidity

Malaysia is a tropical country. Temperature and relative humidity in Malaysia did not differ significantly throughout the year, with fairly steady mean annual temperature and relative humidity ranging from 22 to 32ºC and 70 to 90% respectively (MED, 2013). Commonly, the temperature was increased slightly during the day while the relative humidity decreases from morning to night time. Figure 2a and 2b describes the graph of temperature profile and percentage of relative humidity in two different locations of day-care centres. The result shows that mean temperature of day-care centres in Kuala Lumpur was slightly higher compare to day-care centres in Selangor area. The temperature in day-care centre in Kuala Lumpur was ranging between 25.00-31.70 °C and 24.80-31.40°C in Selangor. The relative humidity for both locations differs slightly with the percentage of 60.80-86.00% and 62.00-87.00% in Kuala Lumpur and Selangor day-care centres respectively.



a **b**

Figure 2a and 2b: Temperature and Relative Humidity in Different Location of Day-Care

Air Velocity and Particulate Matter (PM_{10})

Some of the sources of PM_{10} are included of indoor combustion, indoor chemicals and exhaust from vehicles. Building age, floor type, shelf area, dust from fans, blackboards and curtains were also found to be the determinants of PM_{10} concentration (Ismail *et al*., 2010). Following DOSH, 2010 the PM_{10} level should not exceed 150g/m^3. The PM_{10} levels graph which has significant different result are shown in the figure 3b. The PM_{10} level in day-care centres in Kuala Lumpur was ranging between 58.60-80.70 µg.m^{-3} and the PM_{10} level in day-care centres in Selangor was ranging between 58.30-78.00 µg.m^{-3}. The higher PM_{10} level in Kuala Lumpur could due to the bigger population density which leads to the greater road vehicles and outdoor activities from new infrastructures development and industrial activities in the developing city (Pudpong et al., 2011).

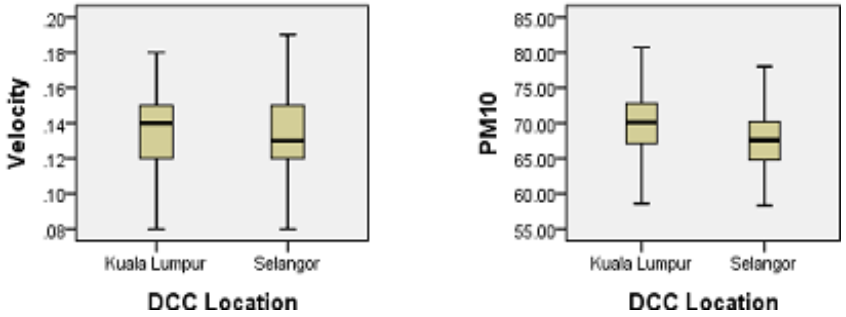
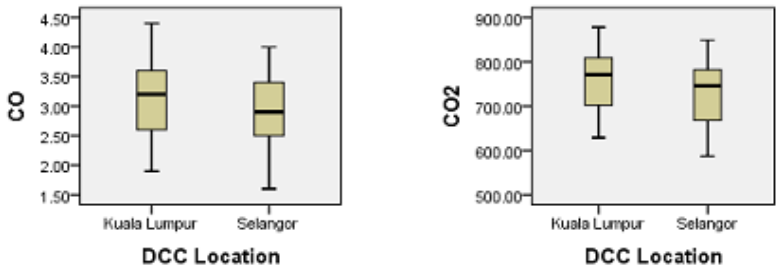


Figure 3a and 3b: Air Velocity and PM_{10} in Different Location of Day-Care

Carbon Monoxide (CO) and Carbon Monoxide (CO_2)

Potential sources of CO are cigarette smoke, gas stove, body odor and outdoor combustion such as nearby roads, parking area and construction sites (Vallero, 2008). Exhaust gas could be also responsible for elevated CO_2 concentration as well as human activity inside the room. According to DOSH, 2010 guidelines, the recommended value of CO concentration for 8 hours period of exposure should be below 10 ppm (parts per million) and 1000 ppm for CO_2. The premise is considered properly ventilated with CO_2 levels between 600-1000 ppm while with CO level greater than 5ppm, the room may have exhaust gas presence inside which need further investigation. If carbon dioxide levels are more than 1000 ppm, there is probably inadequate ventilation and complaints such as headaches, fatigue, and eye and throat irritation may be prevalent (Jones, 2002). The CO and CO_2 concentrations in both day-care locations were also differ significantly ($p \leq .05$). Figure 4a and 4b show the comparison of CO and CO_2 concentration in two day-care centre locations of Kuala Lumpur and Selangor. While the concentration for CO is ranging between 1.90-4.40 ppm and 1.60-4.00 ppm in both locations respectively, the CO_2 concentrations for day-care centres in Kuala Lumpur and Selangor were ranging between 629-878 ppm and 587-849 ppm. The average CO and CO_2 concentrations in day-care centres in Kuala Lumpur area were higher than in Selangor area. Higher levels can result in many sickness symptoms such as headache, nausea and dizziness (Maroni *et al*., 1995).



(a) **(b)**

Figure 4a and 4b: CO and CO_2 in Different Location of Day-Care

CONCLUSIONS

The CO, CO_2 and PM_{10} levels indicated that the city of Kuala Lumpur has higher pollutant levels than suburban area or Selangor. The location of DCC premise plays important part in the final result of this study. The day care premise in high populated city with more heavy traffic and less greenery is proved to have higher concentration of CO and CO_2 and greater PM_{10} level compare to less populated area.

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