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BARRIER OF VENTILATION MODES TO ACHIEVE A BALANCE ENVIRONMENT IN REFURBISHED PRESCHOOLS

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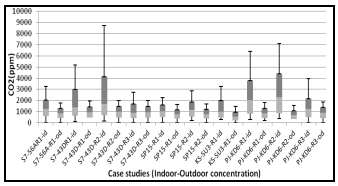
Graphical abstract



Abstract

The preschool education is compulsory to children in Malaysia. This regulation has encouraged more premises to be refurbished as a preschool building. This paper examines the pupils' absenteeism and the prevalence of Sick Building Symptoms (SBS) initiated in congested private preschool with different ventilation. The study analysed data from the attendance record of 10 classrooms and the questionnaire surveys administered to 151 parents about their children health symptoms once they were leaving the schools building. Indoor Carbon Dioxide (CO_2) measured as indicator of the problems. Questions on SBS used 5-point likert scale with symptoms concern on nose, eye, head, throat, skin, breath and tiredness. The descriptive and chi-square test applied to obtain the association of SBS and ventilation strategies in the classrooms. With quantitative and qualitative explanation, the unhealthy environment in refurbished pre-schools explained respiratory symptoms and higher rates of absenteeism frequently reported in air-conditioning (AC) classrooms due to concentrations of CO_2 exceeded 1000 ppm. These symptoms show there were weaknesses in ventilation performance and environment in the selected preschools. Further analyses on objective measurements in future research are strongly recommended.

Keywords: Preschool, ventilation, environment

Abstrak

Pendidikan prasekolah adalah wajib kepada kanak-kanak di Malaysia. Peraturan ini telah menggalakkan lebih banyak premis yang hendak diubahsuai sebagai bangunan prasekolah. Karya ini mengkaji ketidakhadiran murid dan kelaziman Sick Building Gejala (SBS) yang dimulakan pada prasekolah swasta sesak dengan pengudaraan yang berbeza. Kajian ini menganalisis data dari rekod kehadiran 10 bilik darjah dan kaji selidik soal selidik diberikan kepada 151 ibu bapa mengenai anak-anak gejala kesihatan mereka apabila mereka meninggalkan bangunan sekolah itu. Karbon Dioksida Dalaman (CO2) yang diukur sebagai petunjuk daripada masalah. Soalan pada SBS digunakan 5 mata skala likert dengan gejala kebimbangan di hidung, mata, kepala, leher, kulit, nafas dan keletihan. Ujian deskriptif dan khi-kuasa digunakan untuk mendapatkan persatuan SBS dan strategi pengudaraan di bilik darjah. Dengan penjelasan kuantitatif dan kualitatif, persekitaran yang tidak sihat di diubahsuai prasekolah menjelaskan gejala pernafasan dan kadar tidak hadir kerap dilaporkan dalam penghawa dingin (AC) bilik darjah kerana kepekatan CO2 melebihi 1000 ppm. Gejala-gejala ini menunjukkan terdapat kelemahan dalam prestasi pengudaraan dan persekitaran di prasekolah dipilih. Analisis lanjut mengenai ukuran objektif dalam kajian akan datang sangat disyorkan.

Kata kunci: Prasekolah, ventilasi, persekitaran

1.0 INTRODUCTION

Classroom's environment is generally influenced by various contributions, including pupil density, activities, materials and ventilation. Indoor climate is greatly influenced by the effectiveness of ventilation [1]. The term "ventilation" was considered as both the ventilation rate and as an intentional movement of air from outside the building to the inside. Ventilation,as defined in ASHRAE Standard 62.1 and the ASHRAE Handbook, is the air used for providing acceptable indoor air quality. The U.S. Environmental Protection Agency [2] studies found that indoor levels of pollutants may be two to five times and sometimes more than 100 times higher than outdoor levels [3].

Poor indoor ventilation (lack of outside air) attributes to the indoor air quality (IAQ) problems [4], [5]. Ventilation helps remove pollutants and uses "cleaner" outdoor air to dilute the stale or used indoor air that people are breathing. Some building codes specify the amount of outdoor air that must be continuously supplied to an occupied area [6]. However, ventilation modifies the exposures occurring indoors and it cannot remove the indoor pollutions [1]. The outdoor pollution can also access the indoor environment through the ventilation systems. The ventilation requirements are always estimated based on the emission rates of pollutants [1, 7]. Somehow, human response always used to surrogate the ventilation requirement. It is relevant to evaluate the ventilation requirement with the comfort requirement [6], [8] or should be based on health outcomes [1]. An approach to locate the ventilation requirement by observing the building/classrooms, where the elevated risk of health and comfort complaints is suspected once the ventilation rate is at or below the certain level [1].

Operation of a mechanical has been found have both positive and negative effects on health symptoms. Several studies have shown that the installation units effectively reduced asthmatic symptoms and other respiratory problems. [9] in his study cannot prove that wheeze symptom has it significant relation with the type of ventilation. However, few studies demonstrated that improper maintained and operated ventilation system could increase the risk of respiratory symptoms because it can be a source of indoor pollution [10] and causes the improper air exchange rates and elevated of CO_2 concentrations [11], [12]. In hot and humid climate, the respiratory symptoms being reported with the presence of mechanical ventilations in child care center and preschools [12], [13], [14].

A numerous peer-reviewed studies of occupant symptoms have shown no significant relation between the prevalence of symptoms and CO_2 [15], [16], [17]. However, some IAQ investigators have associate indoor CO_2 concentration from 11,000 mg/m^3 (600 ppm (v)) to 1,800 mg/m^3 (1,000 ppm (v)) or higher with perceptions with stuffiness and other indicators of discomfort and irritation [4]. Students occupying rooms with old air handling unit filters reported more symptoms from the eyes, nose and throat than students with newer filters [18]. Thus, indicates HVAC systems can cause indoor air quality problems and/or distribute contaminants throughout a building. High levels of CO_2 can result from inadequate ventilation systems, inadequate air exchanges from the opening and closing of windows and doors [4], and overcrowded classrooms [12], [19] Occupied and air conditioned rooms measured higher levels of CO_2 than rooms cooled with ceiling fans [20]. The presence of a mechanical ventilation system and a large surface of area per child were significantly associated with lower CO_2 levels, explaining 44% of the variance in indoor CO_2 concentrations [19]. Other study findings indicate that low ventilation rates were associated with worsening health or perceived air quality outcomes. Also, the literature associates increase in CO_2 with decreased attendance [13], [21].

School absenteeism is one of the main problems in public and private school. Most of the incidence for total absenteeism and percent of missed days caused upper respiratory infections [22]. Respiratory symptoms also reported to be the number one cause for student absenteeism due to chronic conditions and were the leading cause of hospitalization for children [22].

Somehow, buildings are different from each other in terms of exposure and pollutants occurring indoors. The previous litigations and studies suggested adequate learning environment for these children. According to Seventh Schedule, UBBL [23], the occupant in a classroom requires at least 2 m² per person, which implies a requirement of 40 m² to accommodate twenty pupils in a space. Furthermore, [21] suggested a ventilation rate of 7 l/s for each occupant, with an additional of 0.7-2.0 l/s depending on the expected emissions from the building materials and fittings. It is thus a normal practice to provide a classroom with 270 or 330 l/s fresh air depending on the building material [14]. Therefore the aim of this study was to examine the pupils' absenteeism and the prevalence of Sick Building Symptoms (SBS) initiated in refurbished private preschool with different ventilation during the school years. Indoor Carbon Dioxide (CO_2) measured as indicator of the problems.

2.0 METHODOLOGY

Monitoring performed in 10 classrooms randomly selected (of the 5 preschools). Schools are located in different districts but in 25 km radius with each others. The selections of the schools were based on the similarities of learning and activities systems, foods types serve during recess and school hours. The monitoring of the measurement for CO_2 monitored by the Gray Wolfsensing Solution IQ604 Indoor Air QualityProbe(Gray Wolf sensing Solution, Shelton, CT,

USA). Each monitor was calibrated by the factory once within the calendar year and monthly by the field research team.

Measurement done in three days of each classroom because of the following reason: (1) three as the optimal sample size (verify the mean and the frequency, to identify the valid minimum and maximum results), (2) sampling could be repeated if the instrument fail to measure. It were logging at every 1 minute of measurement. At least 8 hours per day of measurement – (the minimum of exposure to pollutants in determining SBS). Measurements start at 7.30 p.m (atleast 30 minutes before the class starts) and end at 4.30 p.m. The monitors placed within a classroom at least 3 feet away from any wall and atleast 0.5m from bookshelves and out of the children's reach. The monitors always placed on the same size and model step ladder/tripod to approximate the breathing zone.

The classroom/building walk-through form was used by the research team to inventory the building materials and contents of the classrooms. Data were collected to characterise the materials and condition of the ceiling, floor, interior walls, exterior walls, HVAC equipment, and classroom contents. The buildings have been observed on the location of the building from the main road, surrounding activities, numbers of pupils in a classroom mold, dampness, volume of the classrooms and ventilation systems. 151 parents then asked and to fill up the form about their children's health condition and symptoms once their children stay in the preschools' building, Meanwhile, the school administration permitted an access to the attendance records with notice (emergency leave), due to sickness (enclosed with evidence such as notice or medical certificates) and unnoticed leave. Result then to be analysed using Statistical Package for the Social Sciences package 17.0 (SPSS). Descriptive analysis on indoor CO_2 and Absenteeism, meanwhile correlation on non parametric using Chi-Square test applies to determine any relation of sickness absentees with the dwelling's conditions.

3.0 RESULTS

3.1 Building Observations

All the classrooms were operating in double storey terrace house (100m^2). Majority of the classrooms was a bedroom. The walkthrough observation of the building (Table 1) has indicated all the buildings have located in urban, residential area and at the roadside. The environment might enclose to the other factors which can contribute to health effects. Anyhow, the distances of the main road to the buildings are varying. 4 of the classrooms are air conditioning and the other 6 classrooms are natural ventilated with ceiling fan and windows open. The whole classrooms were installed with one ceiling fan each.

Table 1 Building Characteristics

Case Study	S7-56A	S7-43D			SP15		KS-SU3	PJ-KD3		
	R1	R1	R2	R3	R1	R2	R1	R1	R2	R3
Type of building	Double storey terrace house	Double storey terrace house			Double storey terrace house		Double storey terrace house	Double storey terrace house		
Age of the building	8 years	8 years			13 years		2 years	13 years		
Location	Roadside with less traffics	Roadside with heavy traffics			Roadside with less traffics		Roadside with less traffics	Roadside with heavy traffics		
Surrounding details	Urban, residential, commercial area	Urban, residential, commercial area			Urban, Residential		Urban, residential, commercial area	Urban, residential, commercial area		
Constructional activity	No	No			No		No	No	No	No
Distance from main road	500m to expressway	20m			300m		100m	100m	100m	100m
Operation Hour	7am-7pm	7am-7pm			7am-7pm		8am-5pm	8am-5pm		
Occupancy rate	18	21	20	16	16	15	15	20	19	18
Ventilation status	Natural ventilation with ceiling fan, windows open	Air-conditional	Air-conditional	Natural ventilation with ceiling fan, windows open	Natural ventilation with ceiling fan, windows open		Natural ventilation with ceiling fan, windows open	Air-conditional	Air-conditional	Natural ventilation with ceiling fan, windows open
Number of ceiling fan	1	1	1	1	1	1	1	1	1	1

Case Study	S7-56A	S7-43D			SP15		KS-SU3	PJ-KD3		
	R1	R1	R2	R3	R1	R2	R1	R1	R2	R3
Classrooms conditions (damage walls, ceiling, furniture)	Less dusty floor mold stain on the wall	Mold stain on ceiling, less dusty floor	Less dusty floor	Less dusty floor	Dusty floor , full with old paper	Dusty floor	Less dusty floor	Less dusty floor	Less dusty floor	Less dusty floor
Classroom cleaning	Daily after school	Daily after school			Daily after school		Daily after school	Daily after school		
Air-condition filter cleaning	-	annually	annually	-	-	-	-	Annually	annually	-

3.2 Identification of SBS in the Classroom

The health symptom of the pupil (N=151) from selected ten classrooms is reported based on the questionnaires that have been distributed to parents to fill up. This questionnaire represented the pupils' behaviour affected by the classroom's environment. Entire SBS indications of various variables measured to ascertain which factors contributed the most to the symptom. Descriptive analysis was assessed using frequencies with five scales as shown in Table 2 stated number of days annually reported with SBS symptoms. The analysis showed the majority of pupils felt the symptoms of coughing, sore throat and running nose, as these were the common symptoms in this study. The value of these symptoms has a significant association with IAQ.

Table 3 presents the noticeable percentage of health symptoms for every classroom. It has assumed parity of reported health symptoms among classrooms with different ventilation strategies. This section also contributed the further investigations regarding relationships between pupils' health symptoms and other parameters. When responding about their children, most incidents the parents reported were of dizziness, followed by irritation, watery eyes and nausea. The majority of them were reported to be in natural ventilation classrooms (S7-56A-R1 and KD06-R3). A certain relationship has been described between the eyes and nose that affect each other [25].

Table 2 Rating of the Symptoms Reported Annually

N=151	(%) never	*TOTAL UNNOTICEABLE*	Sometimes	slightly	regularly	often	*TOTAL NOTICEABLE*
Headache	26.5	*26.5*	48.3	13.2	6.6	5.3	*73.5*
Running nose	6.6	6.6	31.1	33.8	9.3	8.6	***82.8***
Sore throat	11.9	*11.9*	36.4	33.8	9.3	8.6	***88.1***
Coughing	7.9	*7.9*	38.4	33.8	11.9	7.9	***92.1***
Watery eyes	44.4	*44.4*	31.1	15.9	4.6	4.0	*55.6*
Breathing	66.2	66.2	17.2	9.9	3.3	3.3	*33.8*
Wheezing	68.2	*68.2*	15.9	8.6	3.3	4.0	*31.8*
Dizziness	55.6	*55.6*	25.2	13.2	2.0	4.0	*44.4*
Nausea	64.9	*64.9*	24.5	5.3	0.7	4.6	*35.1*
Fatigue	26.5	*26.5*	27.2	20.5	13.2	12.6	*73.5*
Stress	45.7	*45.7*	28.5	11.9	7.3	6.6	*54.3*
Irritation	70.2	70.2	18.5	5.3	1.3	4.6	*29.8*

Table 3 Noticeable SBS in each Classroom

Percentage Noticeable SBS Symptom	classroom									
	S7-56A-R1[a]	S7-43D-R1[b]	S7-43D-R2[b]	S7-43D-R3[a]	SP15-R1[a]	SP15-R2[a]	SU3-R1[a]	PJ-KD6-R1[b]	PJ=KD6-R2[b]	PJ-KD6-R3[a]
Headache	7.9	13.2	0.0	7.9	13.2	7.9	.0	**15.8**	10.5	23.7
Running nose	9.6	**14.9**	6.4	11.7	10.6	10.6	7.4	9.6	10.6	8.5
Sore throat	6.4	**16.7**	6.4	11.5	9.0	11.5	9.0	10.3	9.0	10.3
Coughing	7.4	**16.0**	6.2	9.9	12.3	9.9	8.6	11.1	7.4	11.1
Watery eyes	10.8	5.4	5.4	2.7	16.2	8.1	10.8	**18.9**	10.8	10.8
Breathing	**16.0**	12.0	4.0	8.0	8.0	12.0	0.0	**16.0**	8.0	**16.0**
Wheezing	12.5	**16.7**	4.2	8.3	12.5	8.3	0.0	12.5	12.5	12.5
Dizziness	10.3	6.9	6.9	10.3	10.3	3.4	0.0	6.9	17.2	**27.6**
Nausea	**18.8**	6.3	0.0	6.3	25.0	12.5	0.0	12.5	12.5	6.3
Fatigue	10.0	10.0	5.7	7.1	7.1	10.0	8.6	10.0	**15.7**	**15.7**
Stress	10.3	7.7	5.1	5.1	10.3	7.7	7.7	15.4	12.8	**17.9**
Irritation	**23.5**	5.9	0.0	0.0	17.6	11.8	0.0	5.9	11.8	**23.5**

a: NV Classroom b: AC Classroom N=151

Nevertheless, respiratory problems (running nose, sore throat, coughing, breathing problems and wheezing) were most commonly reported in air-conditioning classrooms with percentages from 14.9% to 18.9%. Air conditioners might be a wellspring of indoor contamination if their cleaning is irregular, which can prompt the amassing of dirt in the filters. So, it activates the respiratory indications such as sinusitis, rhinitis, asthma and hypersensitive pneumonitis [16].

Table 4 Association of Ventilation Strategies with SBS

Percentage Noticeable SBS Symptom	Classroom Vent		χ^2	*P*
	AC	NaV		
Headache	37.5%	62.5%	0.019[a]	0.890
Running nose	10.0%	90.0%	3.654	0.056
Sore throat	11.1%	88.9%	6.438	0.011*
Coughing	8.3%	91.7%	4.985	0.026*
Watery eyes	38.8%	61.2%	0.008	0.929
Breathing	36.0%	64.0%	0.727	0.394
Wheezing	36.9%	63.1%	0.315	0.574
Dizziness	34.5%	65.5%	1.535	0.215
Nausea	35.7%	64.3%	0.858	0.354
Fatigue	25.0%	75.0%	6.438	0.042*
Stress	41.5%	58.5%	1.444	0.230

**Significant at P<.05* *N=151*

Table 4 shows the sore throat and fatigue were connected with the classroom's ventilation strategies with ($\chi 2$ = 6.438, p <0.005), ($\chi 2$ = 4.985, p <0.005) and ($\chi 2$ = 6.438, p <0.005), respectively. It specifies that natural ventilation classrooms contributed higher applicable health indications to pupil contrasted with AC classrooms owing to the outside contaminants entering the classrooms through the open windows. On the other hand, the air-conditioned S7-43D-R1 committed the most astounding number of pupils endured the symptoms. Further studies conducted on familial and pupils' history to discover the affiliation of the symptoms.

3.3 Absentees among Pupils

Table 5 outlines distinct statistics of the absentees' information from the selected classrooms. Figure 1 has indicated that the three highest absentees due to sickness were reported from the air-conditioned classrooms, namely S7-43D-R1, S7-43D-R2 and PJ-KD3-R2 with the rate of 6.25%, 5.46% and 5.08% of yearly non-attendance, respectively. Further cross-sectional studies about absenteeism, pupil's general particulars, parents' health conditions, pupils' health problems, reported SBS among pupils and houses/dwelling characteristics have been carried out in the other sections of this research study. The absentees for NV and AC classrooms did not provide the same value. The air-conditioned classrooms indicated higher rates of annual absentee because of the sickness (Table 6). Nevertheless, there was no link found between the ventilation strategies and annual leave among pupils. The absenteeism in air-conditioned classrooms was higher than the natural ventilation classrooms with 32.8% of pupils, who were absent for more than 20 days in a year because of sickness belonged to the air conditioned classrooms.

Table 5 Percentage of Annual Absenteeism

	TOTAL % ABSENCE BY SCHOOL			
Classroom	**Noticeable**	**Sick**	**Unnoticeable**	**TOTAL**
S7-56A-R1*	1.48%	4.27%	0.33%	6.08%
S7-43D-R1**	**2.12%**	**6.25%**	**1.51%**	**9.88%**
S7-43D-R2**	**0.67%**	**5.46%**	**0.27%**	**6.40%**
S7-43D-R3*	1.07%	4.03%	0.29%	5.39%
SP15-R1*	2.86%	4.37%	1.61%	8.83%
SP15-R2*	2.96%	4.31%	1.72%	8.99%
SU-R1*	2.04%	4.57%	0.28%	6.90%
PJ-KD3-R1**	1.74%	4.66%	0.39%	6.80%
PJ-KD3-R2**	**1.26%**	**5.08%**	**0.43%**	**6.77%**
PJ-KD3-R3*	1.82%	4.31%	0.62%	6.74%

*Natural ventilation, ceiling fans and windows open **Air-conditioning classroom

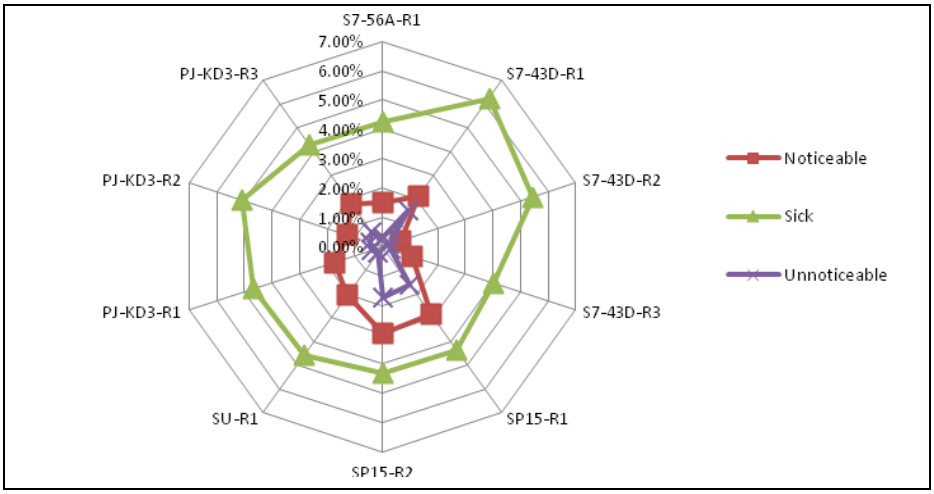


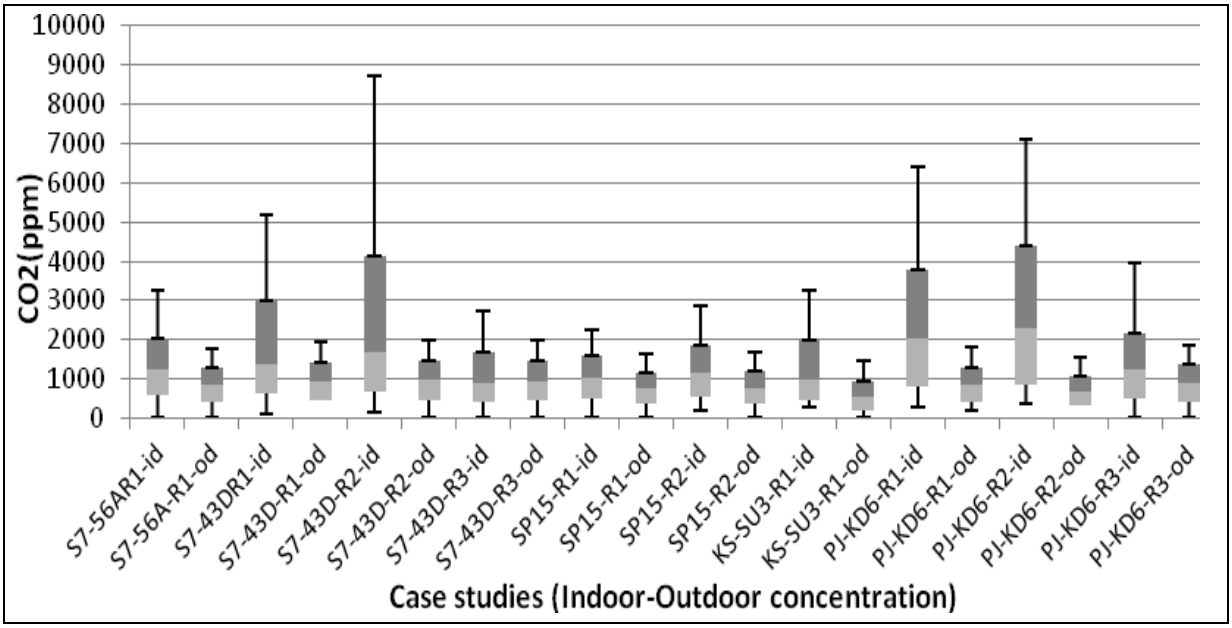
Figure 1 Annual Absenteeism According to Classrooms

Table 6 The Annual Absentees According to Ventilation Strategies

Classrooms	% Annual Absenteeism: Sickness		
	<3% absence (less 7 days)	3%-6% Absence (7-20 days)	>6% absence (more 20 days)
Air conditioned classrooms	32.8%	34.5%	32.8%
Naturally Ventilated classrooms	40.9%	43.0%	16.1%

3.4 CO_2 Characteristics in the Classrooms

Indoor CO_2 concentrations have been referred as an indicator of IAQ. Figure 2 demonstrates the box plot of the indoor-outdoor for the mean value of CO_2. The concentrations of both points oscillated and resulted in an insignificant relationship corroborate with negligible influence of outdoor CO_2 concentration over the indoor concentration. This can be noticed in Figure 3 and Table 7, where the mean values of outdoor CO_2 range between 326.13 ppm to 488.25 ppm. In contrast to the outdoor CO_2, the indoor CO_2 concentration behaved in a totally different manner. However, the level of CO_2 is also affected by the ventilation strategies and the number of occupants in the classrooms. The air-conditioned (S7-43D-R2) classroom with a density of 22 pupils stated the highest mean value of CO_2 at 1680.0 ppm. Followed by PJ-KD6-R2 (AC classroom), with 20 pupils, at 1295.0 ppm. CO_2 mean value concentration for PJ-KD6-R1 (pupils density= 19) was found to be 1293.0 ppm, whereas air-conditioned classroom (S7-43D-R1), with 19 pupils, showed the value of 1054.0 ppm of CO_2 mean value.



id: indoor measurement point
od: outdoor measurement point

Figure 2 Indoor and Outdoor Carbon Dioxide, CO_2 at 10 Classrooms

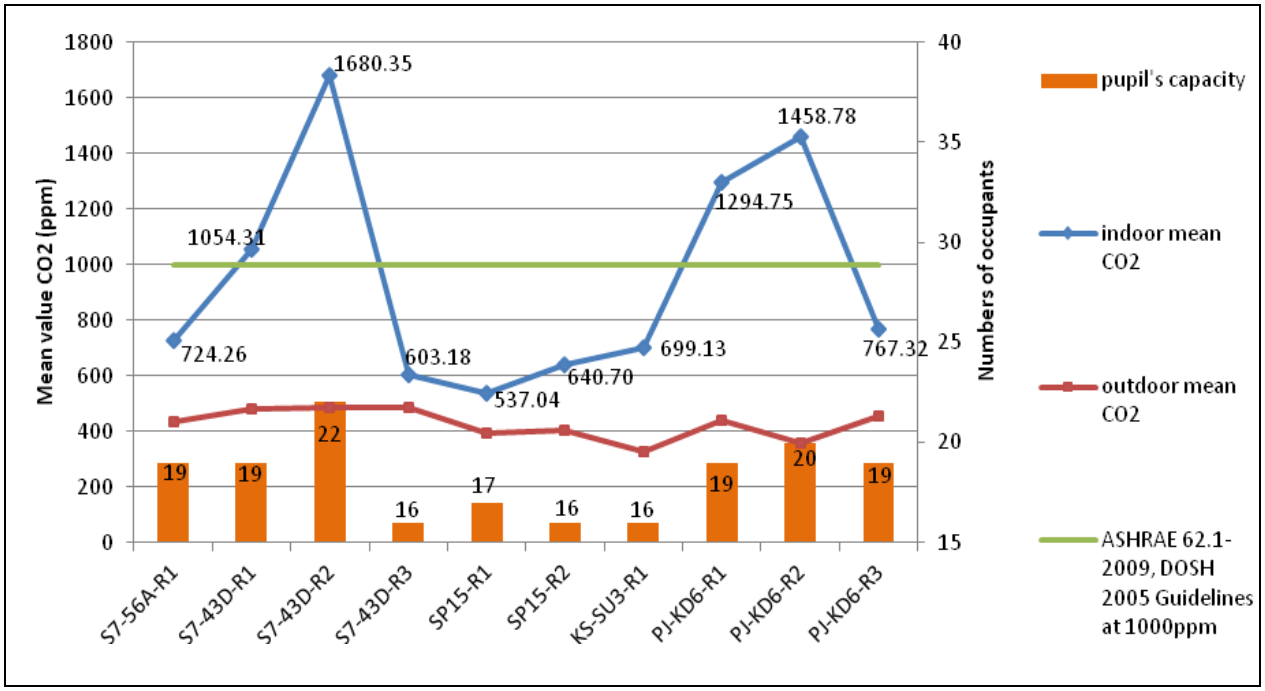


Figure 3 Mean CO_2 Concentration and Occupants between Classrooms

The four aforementioned air-conditioned classrooms have exceeded 1000 ppm that is the postulated standard limit in the Malaysian code of practice [26] and ASHRAE Standards [6]. The rate of CO_2 when exceeds 1000 ppm, it can cause the chest tightness or worse, suffocation [3]. It triggers the potential of respiratory illnesses such as influenza and common colds [1].

Table 7 Indoors and outdoors CO2 Concentrations for Every Classrooms

Classroom	Indoor				Outdoor				I/O
	Minimum	Maximum	Mean	S.D	Minimum	Maximum	Mean	S.D	
S7-56A-R1	551.70	1202.70	724.26	171.77	398.70	475.30	435.92	15.06	1.66
S7-43D-R1	521.30	2186.00	1054.31	515.08	442.30	514.30	480.56	12.89	2.19
S7-43D-R2	526.00	4576.70	1680.35	1184.46	445.70	523.00	488.25	13.43	3.44
S7-43D-R3	418.00	1050.30	603.18	192.83	442.30	525.00	487.11	17.93	1.24
SP15-R1	449.00	662.00	537.04	48.91	338.30	447.00	393.62	26.82	1.36
SP15-R2	337.70	1005.50	640.70	123.99	344.30	463.00	404.43	27.32	1.58
KS-SU3-R1	158.70	1276.70	699.13	288.09	147.00	526.50	326.13	100.03	2.14
PJ-KD6-R1	509.00	2627.50	1294.75	550.69	228.50	482.00	438.71	19.56	2.95
PJ-KD6-R2	478.00	2709.00	1458.78	658.08	0.00	460.00	359.60	53.99	4.06
PJ-KD6-R3	500.00	1793.00	766.86	281.94	407.00	516.00	455.06	19.29	1.69

Meanwhile, the naturally ventilated classrooms (S7-56A-R1, S7-43D-R3, SP15-R1, SP-15-R2, PJ-SU3-R1) seem to have a decent IAQ, where the indoor CO_2 mean value concentrations were below the DOSH (2010) and ASHRAE 62.1-2013 limit. Although, S7-56A-R1, S7-43D-R1, PJ-KD6-R1 and PJ-KD6-R3 had the similar pupils' density at the same time, but the mean values of CO_2 varied as the ventilation strategies were changed.

3.5 Associations of Preschools' Indoor IAQ with the Health Symptoms and Absenteeism

The investigation towards CO_2 in ten classrooms has discovered it was inadequately dispersed. The tested pupils were children of ages between four to six years and they were also vulnerable to air contaminant (EPA, 2006). The health symptoms were approachable, once the pupils were in the exposed buildings. By some means, it was governed by the dose of pollutants and body competency reacting towards the contaminants. This section is presents the association of classrooms' CO_2 with health symptoms and annual school attendance among pupils.

The Spearman-Rho Correlation [2] indicates CO_2 level had weak associations with the respiratory symptoms (running nose, sore throat and coughing) and the higher levels of indoor-generated CO_2 was present in poorly ventilated classrooms. Several studies have demonstrated that the building with insufficient ventilation may result in elevated transmission of communicable respiratory ailments among the occupants [27, 21]. This is identical with the possibility of amplified risks of constricting certain transmissible respiratory diseases such as influenza and common colds in classrooms with low ventilation rates [27]. The result in this study showed that the relative risks for chronic phlegm/ running nose, sore throat and cough can be associated with the CO_2 concentration level. The previous results have shown that the symptoms of chronic coughing, sore throat and fatigue were significantly related to the scarce ventilation within AC classrooms. Table 8 visualizes the correlation of Indoor CO_2 with health symptoms and absenteeism of sickness.

Table 7 Correlation of Indoor CO_2 with Health Symptoms and Absenteeism of Sickness

	Headache	Running nose	Sore throat	Cough	Watery eyes	Breathing problem	Wheezing	Dizziness	Nausea	Fatigue	Stress	Skin irritation	Absenteeism due to Sickness (<20 days)
R	0.026	**0.169***	**0.198***	**0.186***	0.037	0.075	0.040	0.103	0.124	**0.204***	0.099	-0.011	0.129
p	0.747	**0.039**	**0.015**	**0.022**	0.648	0.363	0.625	0.223	0.128	**0.012**	0.225	0.890	0.116

*significant at 0.05 level **significant at 0.01 level

4.0 CONCLUSION

In view of IAQ performance in refurbished private preschools it would be understandable to find that some sources are originated from indoor such as occupants and ventilation strategies. The results of the measurement show the differences arise, due to the advantage of the indoor environment.

Particularly with the high density of pupils in the classrooms in air condition classrooms has invited the high level and insufficient indoor CO_2. This is seen particularly when the high level indoors in the classroom environment contrast strongly with the air outside the pre-school building. The adapted space function which previously is bedrooms is inadequately to provide a good air quality and invited few health symptoms. The improper ventilation strategies has encourage some symptoms to children especially to those are really sensitive on the presence of few parameters with the minimum dose. Yet, the symptoms of health problems may not begin when children being at school. The environmental factors such as urbanisation, industrialisation, air pollution, hygienic conditions, renovation, mould and smoke exposures, building and furnishing materials and diet have been related to increased or decreased risk, and thus prevalence, of allergic diseases and could potentially explain a part of the factor. This type of study should be extended to the biological contaminants and widely apply to other numerous of refurbished pre-schools in order to be better able sustaining the IAQ management strategies and to apply source apportionment methodologies. The outcomes of the studies are foreseen as a benchmark for future research to improve the preschools physicals' environment.

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