A QUANTITATIVE EVALUATION OF THE INDOOR ENVIRONMENTAL QUALITY IN REFURBISHED KINDERGARTENS: A STUDY OF MALAYSIA CONDITION

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Abstract

In the Malaysian context, the coverage of kindergarten education has improved dramatically in recent times although many kindergartens are located in buildings that were not originally designed for that purpose. Indoor Environmental Quality (IEQ) is considered to be one of the most important factors affecting the physical development of children. Hence, it is essential to evaluate the indoor conditions of those kindergartens which are based in buildings that have been refurbished and adapted from their original purpose for kindergarten usage. It is posseted that such refurbished environments provide sub-optimal IEQ to support appropriate conditions for kindergarten use which is reflected in user perception and satisfaction. This study presents the results of the IEQ investigations conducted in refurbished kindergarten buildings in Malaysia with the cardinal focus on identifying occupants' satisfaction with the various IEQ factors. The study aims to utilize the results of this work to develop a benchmark for analogous studies. A total of 240 refurbished kindergarten buildings in Malaysia were studied to evaluate occupants' perceptions and levels of satisfaction. The results indicate that the occupants found "Air Movement", "Ventilation", and "Freshness" to be of a poor quality due to the high occupancy density. The "Noise" factor was the least satisfactory IEQ factor due to closeness of the kindergartens to the main roads (external noise), as well as the small size of classrooms (internal noise). Moreover, it was found that "Color" and "Attractiveness" are the most important IEQ factors from the occupants' viewpoint. This study provides a practical benchmark in conversion of buildings' usage.

Keywords: *Indoor Environmental Quality, Post-Occupational Evaluation, Refurbished kindergarten buildings, Occupants' Perception*

1. INTRODUCTION

Indoor Environmental Quality (IEQ) plays an important role in influencing comfort and efficiency of occupants in indoor environment. Physical comfort, which refers to satisfaction of fundamental needs of occupants such as adequate lighting and space allocation for each individual, and psychological comforts, involving satisfaction of occupants with their colleagues, management, and feeling of

enjoyment are factors associated with the occupants' comfort with regard to IEQ. Many studies (Montzamani et al., 2012; Putih et al., 2014; Mendell and Heath, 2004; Treputtharata and Tayiam, 2014; Sulaiman et al., 2013; Lee et al., 2012; Huang et al., 2012; Passero and Zannin, 2012 and Hawes et al., 2012) have identified the contribution of both physical and psychological factors associated with the occupants' satisfaction in various workplaces. However, the concept of IEQ has gained more prominence as the lifestyle in developed countries has resulted people spending the majority of their time (approximately 90%) within indoor environments (U.S., 1996). School children spend about 30% of their time at school, as such there is a potential influence of the indoor environment in that setting upon their future development (De Guili et al., 2012). Although both adults and children are affected by the poor IEQ, young children are arguably of greater concern due to their susceptible immune systems (Montzamani et al., 2012; Zhang et al., 2006; Mendell and Heath, 2004). Among the different physical discomforts derived from poor IEQ, fatigue condition and sick building syndrome have been reported as the most common discomforts in buildings (Musa et al., 2012; Mendell and Heath, 2004; Tarcan and Varol, 2004; Frontczak and Wargocki, 2011; Issa et al., 2011). Studies also show that the health impairment of students and teachers resulting from poor IEQ could influence students' performance, behavior, and productivity (Mendell and Heath, 2004; Treputtharata and Tayiam, 2014; Lee et al., 2012; Earthman, 2004; Huang et al., 2012; Passero and Zannin, 2012 and Hawes et al., 2012). Uline and Moran (2008) have reported the lack of tendency of academics to focus when the learning process is taking place in imperfect environmental conditions.

Due to the importance of IEQ in schools, many studies have identified building characteristics that affect the occupants' health and performance. These include indoor air quality, temperature, odors or olfactory effects, visuals, acoustics, daylight and artificial lighting, ergonomics and space (Rosen and Richardson, 1999; Buckley et al., 2004; Mendell and Heath, 2004; Shendell et al., 2004; Yang et al., 2009; Zhang and Barret, 2010; Montzamani et al., 2012; Putih et al., 2014; Pegas et al., 2012). These factors, individually or in combination influence the comfort of occupants in buildings; occupants within the same environment often cite differing levels of satisfaction or dissatisfaction with these indoor conditions. One reason is that individuals respond differently to the same conditions. Another

reason could be that it is difficult to identify a direct factor affecting occupants' discomfort and health symptoms (Sulaiman et al., 2013; Chiang and Lai, 2002).

There is a dearth of sufficient information on occupants' perceptions of IEQ influences in refurbished kindergarten buildings in Malaysia. Hence this paper sought to identify occupants' needs, satisfaction and comfort levels with reference to IEQs. The approach taken was to apply a method of Post-Occupancy Evaluation (POE) to identify and assess these. This study particularly involves the systematic application of POE, to a sample of 240 kindergarten buildings, to gauge the perceptions of occupants relating to IEQ within the various buildings and to consider the impact of IEQ on occupant comfort and performance. The outcome of this process was used to inform an investigation as to how well the refurbished kindergarten buildings meet the occupants' requirements.

The objectives of this study are: i) to determine the satisfaction level of the building occupants in terms of indoor environment, ii) to assess the importance of IEQ factors relative to overall satisfaction and comfort in refurbished kindergarten buildings, and iii) to identify any correlation between individuals' liking scores for individual IEQ factors and their overall perception of the indoor environment. The ultimate objective of this study is to identify the most significant or critical IEQ factors affecting overall satisfaction in order to inform approaches for improving buildings design, performance and comfort levels. In addition this should allow the creation of a set of benchmarks for appropriate IEQ in refurbished kindergarten buildings in Malaysia.

2. REFURBISHED KINDERGARTEN BUILDINGS IN MALAYSIA

In the Malaysian context, the coverage of kindergarten education has improved dramatically in parallel with the government's policy of making kindergarten programs compulsory (Ministry of Education, 2001). Figure 1 shows the number of private kindergartens in Malaysia registered with the Ministry of Education. As can be seen, there is a remarkable rise in the number of private kindergartens from 2461 in 2000 to 7550 in 2013 (Educational Planning and Research Division, 2013; Tenth Malaysia Plan, 2010). The Malaysian Government's goal aiming at a noticeable increase in the enrolment of young

children (aged 4+ and 5+) in kindergartens from 67% in 2010 to 87% in 2012 has been achieved (Tenth Malaysia Plan, 2010).

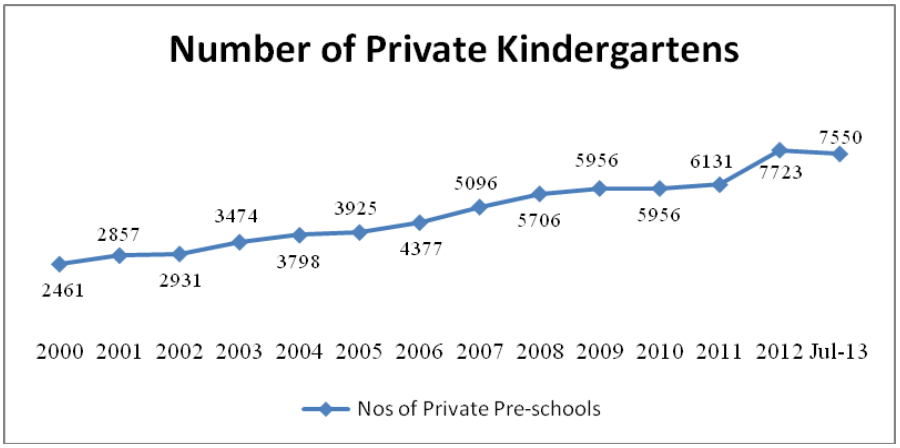

Figure 1. Number of private kindergartens in Malaysia, 2000 to July 2013

The private kindergartens in Malaysia have been frequently converted from the previous housing, commercial or institutional buildings. Figure 2 shows different types of premises converted to private kindergartens in Kuala Lumpur, Malaysia (Chiang and Lai, 2002). Among all, Double Storey Houses followed by Single Storey Houses contribute to the highest conversion of buildings' usage, with approximately 65% and 21%, respectively. Figure 3 shows a typical private refurbished kindergarten building, in which the bedrooms of the Double Storey House were converted to the classrooms.

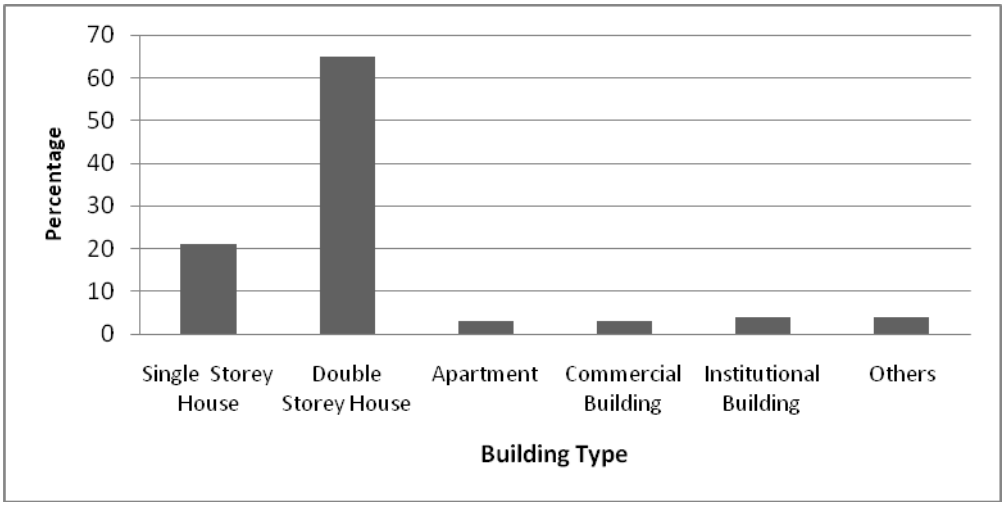

Figure 2. Type of private kindergartens' premises in Kuala Lumpur

Figure 3. Double storey link house refurbished as a kindergarten

The number of pupils in the refurbished kindergarten buildings is usually up to 40, of which 15 to 20 are in each classroom. Each classroom is supervised by three teachers and two teaching assistants. Generally, each individual occupant in the classroom requires at least 2 m^2 spaces (Uniform Building By Law Act 1333, 2009), while the actual given space for all students in a class in the refurbished kindergarten building in Malaysia is 9 - 23 m^2 per room. Figure 4 illustrates a typical classroom in a refurbished kindergarten building in Malaysia.

Figure 4. A bedroom converted to a classroom

The nature of the refurbished buildings also has implications in terms of location and the subsequent impact upon IEQ. Many Kindergartens are located on congested streets, which can result in disruption of classes and affect the comfort of occupants. Assessment of IEQ factors in kindergartens located in such congested areas is very important and yet challenging.

3. RESEARCH METHODOLOGY AND MATERIALS

This study investigates the Indoor Environmental Quality (IEQ) of refurbished kindergarten buildings in Malaysia. 1000 kindergartens were randomly selected from the approved list of Ministry of Education Malaysia (EPRD MOE, 2013). The kindergartens were selected according to the type of building (Double Storey Terrace, Single Storey Terrace, Bungalow, and Institutional building), the floor area and size of the building (80 m^2 - 420 m^2), and the type of ventilation (natural ventilation and/or mechanical ventilation). Firstly, a letter of permission sent to 1000 kindergartens to seek for permission in participating questionnaire survey. Out of 1000, 240 kindergartens have granted the permission to conduct research in their premises.

The study involves two stages; (1) survey questionnaires, and (2) field observations. In the first stage, the questionnaires were distributed among the buildings' occupants and the feedback was collected accordingly to be interpreted by the experts. The reason for employing this method is that a questionnaire survey provides the most economical and efficient way of gathering standard and stable information from a large sample of individuals (Bluyssen and Cox, 2002 and Sarantakos, 1988). Hence, this approach was applied in this study to assemble data from the large population spread all over the country. The second stage of the study involves walk-through observation of buildings, identifying individual characteristics of each building in order to identify the setting and context, physical configuration, and physical and environmental features of each the refurbished kindergarten buildings. This approach was used to ensure that the data gathered from the questionnaire could be contextualized with the various physical environments that provide the kindergarten facilities. Any specific physical characteristics affecting the IEQs or the general operation of the kindergarten could be identified in this way.

3.1 Questionnaire

In order to obtain a good response rate, the questionnaire was designed to be only four pages long. It used a simple format and structure that would not take long for the respondents to answer. Space was also provided for the respondents to give additional free-form comments. Before the questionnaire was sent out, it was piloted with 10 potential respondents from two pre-schools, whose comments and suggestions were taken into consideration in the final version. Covering letters and questionnaires were distributed by hand to school administrative staff, to gain permission. The questionnaires were then collected within two weeks, during the building observation. Of the 1,020 questionnaires distributed around peninsular Malaysia (to 5-7 staff, in 240 pre-schools; 711 classrooms), 521 were returned of which 57 remained unanswered and 60 were incomplete. That is, 404 questionnaires were found to be useful.

The valid response rate recorded was almost 40%, which is sufficient for a social science study in Malaysia. Krejcie and Morgan's table to determine sample size shows that, for a population of 1,100, the minimum acceptable size is 285 (Krejcie and Morgan, 1970). In this study, the response rate of 404 can justifiably represent the total population.

Table 1: Internal Environment Factors

Q1	-Noise level	Q12	-Health when in the room
Q2	-Electric lighting	Q13	-Colours of the room
Q3	-Amount of daylight	Q14	-Attractiveness of the room
Q4	-Glare level in the room	Q15	-Control over local environment
Q5	-Distance to the windows	Q16	-Workspace
Q6	-Room temperature	Q17	-Privacy
Q7	-Ventilation	Q18	-Immediate colleagues
Q8	-Amount of air movement	Q19	-Management
Q9	-Freshness of your room	Q20	-Workplace, in general
Q10	-Humidity level in the room	Q21	- Outward appearance
Q11	-Smell in the room		

The survey questionnaire used as part of the Post Occupancy Evaluation (POE) to provide information regarding the occupants' perceptions of Indoor Environmental Quality (IEQ) of the buildings. The questionnaire was adapted from Levermore et al.'s questionnaire, developed in the UK, which is used by a number of organizations including London consultancies. Due to immaturity of the young children in the kindergartens, the selected respondents were adult-occupants whom were considered to be better able to evaluate the environmental conditions of the buildings. In order to obtain

a higher response rate, the questionnaire was designed to be only four pages long. The questionnaire used a simple and understandable structure; so that it would not take long for the respondents to answer. Adequate space was provided for the respondents to give additional free form comments. The questionnaire is made up of two sections as described below.

Section (A): Questions about general information, such as age, gender, work experience, etc.

Section (B): Explores attitude and perception of the occupants towards the twenty-one IEQ factors provided in Table 1.

The occupants were asked to rate their answers on a seven-point Likert scale for "User satisfaction" and "Degree of importance". The results were then used to elicit an occupant satisfaction score in order to develop a benchmark for building satisfaction.

The seven-point scales were as follows;

How much do you like/dislike …?

-3	-2	-1	0	1	2	3
Strongly dislike	Dislike	Slightly dislike	Neither	Slightly like	Like	Strongly like

How important do you consider…?

1	2	3	4	5	6	7
Extremely unimportant	Unimportant	Slightly unimportant	Neither	Slightly important	Important	Strongly important

Regression analysis was used to determine correlation between individual scores and the overall rating of the building.

3.2 Building Observations

A walk through inspection was used by the research team to contextualize the physical environment of each building and to compile an inventory of the building materials and contents of the classrooms. The purpose of the walk through survey was to provide physical assessment of the buildings and to identify,

in a systematic way, physical aspects or building characteristics that might have an influence upon occupant satisfaction, internal environment or perceptions of IEQ factors. Walk through surveys have been successfully utilized as part of POE for education facilities within various POE models and approaches allowing the triangulation of physical data from the building with data relating to perceptions of building users. (Riley et al, 2010). Data were collected to characterize the materials and condition of the ceiling, floor, interior walls, exterior walls, Heat, Ventilation and Air Conditioning (HVAC) equipment, and classroom contents. This included visual inspections to check and record the physical design and conditions of the classroom contents. Among the specific items inspected were water stains, mould, air fresheners, candles, pesticides and traps, odors, general cleanliness and lighting quality. These items have been frequently identified as sources of IEQ problems during building inspections (Educational Planning and Research Division, 2013). Location of the building relative to the main roads, surrounding activities, the number of pupils in each classroom, mould and damp, the volume of the classrooms, and ventilation systems were also investigated.

3.3 Analysis Methods

Answers to the questionnaires indicate the occupants' ratings of their satisfaction with the indoor environment as well as providing indication of how important they find each of these individual environmental factors.

The first part of the analysis determines the satisfaction score, or overall liking score, of a building, representing an overall rating for a buildings' indoor environment, using Equation 1 [33-35]:

$$\mathrm{OLS} = \left[\frac{\sum_{k=1}^{n} \sum_{j=1}^{m} i_{j,k} l_{j,k}}{mni_{\max} l_{\max}} \right] 100 \qquad (1)$$

where

j = questionnaire number

k = question number

i = importance rating 1 < = i < = 7

i_{max}= maximum value of i, (7)

l_{max}= maximum liking rating l (+3)

l = liking rating -3 < = l < = +3

m = number of completed in questionnaires

n = number of questions in the score

The second part of the analysis provides a graphical representation of the totals for each answer. This is called a "user satisfaction fingerprint" and normalizes each question to a score between -100% and +100% (Levermore, 1994, 1994a, 1999, 2000), using Equation 2.

$$FLS = 100 \left[\frac{\sum_{j=1}^{m} i_{j,k} l_{j,k}}{m i_{max} l_{max}} \right] \quad (2)$$

The third part of the analysis is similar to the second. However, using Equation 3, a normalized individual score for each person can be calculated.

$$FLS = 100 \left[\frac{\sum_{k=1}^{n} i_{j,k} l_{j,k}}{n i_{max} l_{max}} \right] \quad (3)$$

This score will be between +100% and -100%.

3.4 Factor Analysis

Factor analysis combines two or more variables into a single factor, allowing data derived from a large number of variables to be distilled to allow identification a smaller number of key, significant factors. The correlation between two variables can be summarized in a scatter plot. Previous studies have used Factor Analysis to establish the underlying dimensions of the occupant questionnaire on indoor environment conditions. A Principal Axis Factor (PAF) with a varimax (orthogonal) rotation on

the 21 Likert-scale questions from this occupant's perception's questionnaire was conducted based on the occupants' perception toward twenty-one IEQ factors.

4. RESULTS

4.1 Building observations

The data gathered as part of the building walk-through survey was correlated with the perceptions of the occupants towards the building. Of the 240 participating private kindergarten, 92.9% are operating in refurbished residential premises, mostly rented Two-Storey Terraced Houses (67.1%) with 100-199m^2 of floor area. Two-thirds of the buildings are located on medium-local streets with moderate traffic flow less than 50m from the premises. Surprisingly, 96.6% of the classrooms (N=711) identified did not comply with Uniform Building by Laws (UBBL) requirement of space per person in classrooms.

The descriptive analysis of building observations is detailed in Table 2. The most frequent occurrence of each characteristic is shown in bold.

Table 2: Descriptive analysis of refurbished kindergarten buildings

Categorical Variables (N=25)	Description	%
Building types	Single Terrace	11.0
	Double Terrace	**67.1**
	Single Bungalow	4.6
	Double Bungalow	10.1
	Shop/office	0.8
	Others	6.3
Ownerships of the building	Owned	34.2
	Rented	**65.8**
Age of the building years	<5	5.9
	5-10	28.7
	10-15	**33.3**
	15-20	14.3
	20-30	16.0
	>30	1.7
Programme	**Kindergarten only**	**58.2**
	Daycare only	3.4
	Kindergarten+Daycare	30.8
	Kindergarten +Tuition	3.4
	Kindergarten+Daycare+Tuition	4.2
Age of pupils	>4years	1.7
	4-6	69.2
	7-8	1.3
	>9	20.7
	Infants (0 months-3years)	7.2
Total floor area	<100m^2	9.7
	100-199m^2	**79.3**
	200-299m^2	7.2

	300-399 m^2	3.0
	>399 m^2	0.8
Classroom floor area (mean ± standard deviation)		15.51±5.98 m^2
Open area per classroom (mean ± standard deviation)		5.30±1.53 m^2
Numbers of pupils and teachers per classroom (mean ± standard deviation)		16 ± 4
Required space (minimum $2m^2$ per person)	**not compliant**	96.6
	compliant	3.4
Ventilation type	Dominantly natural	33.8
	Dominantly air-conditioned	**36.3**
	Both	29.9
Traffic type	Small local street	12.7
	Medium local street	**65.0**
	Large local street	16.0
	Expressway	6.3
Traffic density	Low	30.4
	Medium	**54.9**
	Heavy	14.8
Floor surface	**Smooth**	**84.8**
	Carpeted	15.2
Curtain types	**None**	**62.9**
	Blinds	7.6
	Textiles	29.5
Recent renovation	Yes	54.4
Cooking activities	Yes	70.9
Dampness	Yes	52.3
Mould growth	Yes	54.0
Vermin absent	Yes	76.0
Soft toys	Yes	85.2
Floor cleaning	Twice a day	30.4
	Daily	69.6
Fan cleaning	Twice a week	8.0
	Weekly	85.0
	monthly	26.5
Shelf cleaning	Daily	28.7
	Twice a week	19.8
	Weekly	51.5
Table cleaning	**Daily**	66.2
	Twice a week	28.7
	Weekly	5.1
Toilet cleaning	**Daily**	78.5
	Twice a week	19.8
	Weekly	1.7
Curtain cleaning	Weekly	6.3
	Monthly	46.4
	Bi-annually	26.6
	Never	20.7

4.2 Occupants' survey

The opinions of adult-occupants in regard to the degree of each IEQ factors have been collected through the questionnaires. Figure 5 shows the satisfaction score of the distinct buildings' characterizations given by the adult-occupants. It can be seen that the "Noise" factor was given the lowest satisfaction score, whereas the "Colleagues" factor was granted the highest satisfaction score.

The adult-occupants mentioned the external noise level as the most disturbing factor with the lowest satisfaction score of – 13.77.

The adult-occupants also gave less favourable satisfaction scores to the "Smell" (+10.22), "Humidity" (+16.50), and "Freshness" (+17.95). In contrast, the other three air quality factors, including "Air Movement", "Ventilation", and "Temperature" were given higher satisfaction scores of +24.00, +22.36, and +19.73, respectively.

Daylight which is critical to the well-being of building's occupants was given relatively a high score, indicating its importance in IEQ.

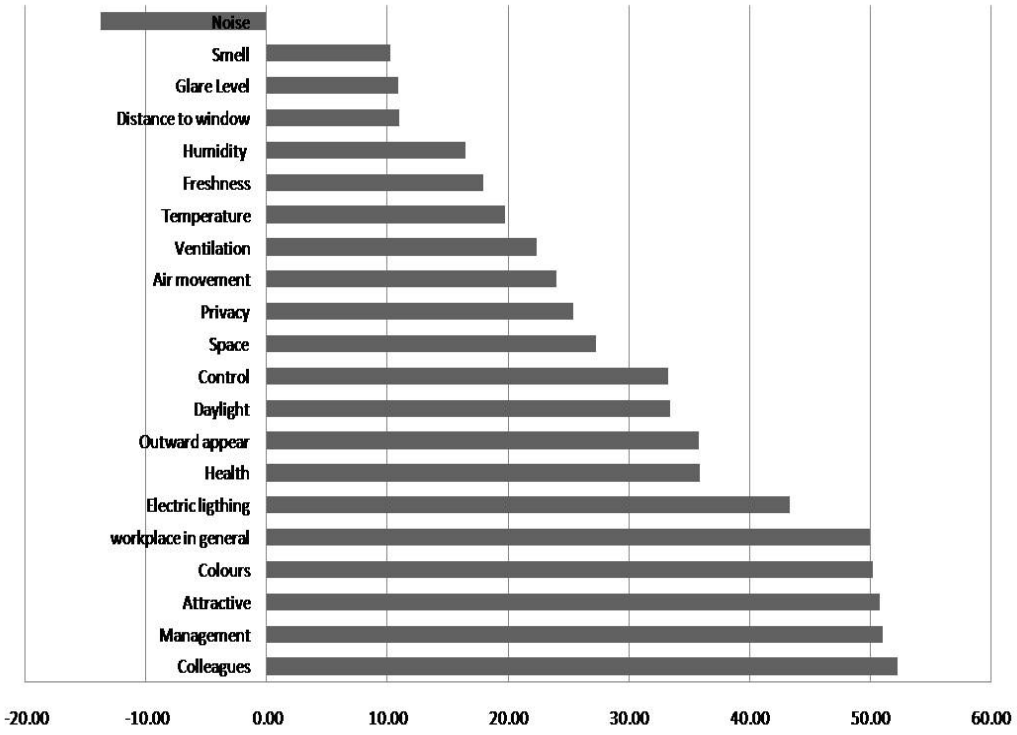

Figure 5. Audit satisfaction fingerprint

4.3 Perceived Degree of Importance of Factors in the Design or Refurbishment of Occupants' Ideal Buildings

The attitude and perception of adult-occupants regarding the importance of twenty-one IEQ factors were ranked. All the factors were given the score greater than 5, indicating that the occupants considered the IEQ factors of highly important in the selection of suitable workplace.

Figure 6 shows the average importance ranking of IEQ factors in the pertinent kindergartens. The response from the total of 404 adult-occupants reveals that the "Color" is the most important factor followed by the "Attractiveness".

The Glare Level, Distance to the Window, Humidity, Noise and Smell were given the least scores implying their less important value from the adult-occupants' standpoint.

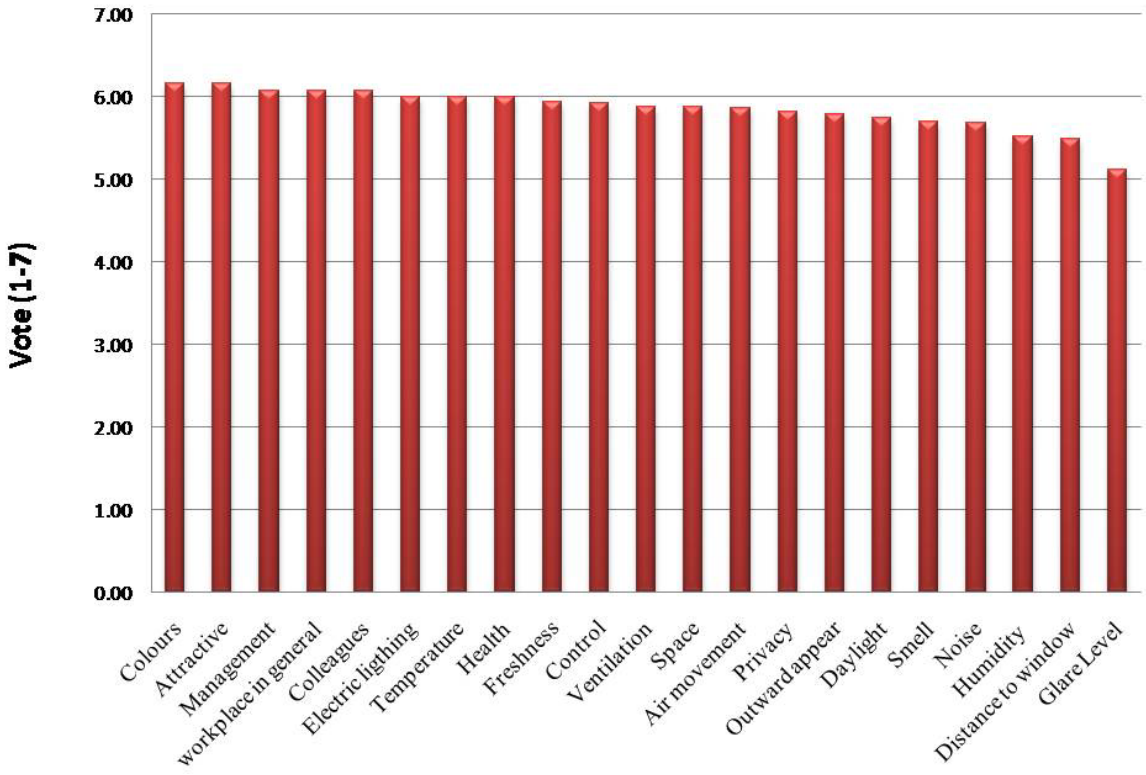

Figure 6. Average Importance Score Ranks

4.4 Factor analysis

Firstly, 21 variables correlated at least .3 with at least one other item, suggesting reasonable factorability. An examination of the Kaiser-Meyer Olkin measure of sampling adequacy suggested that

the sample was factorable (KMO=.876), that is above the recommended value of .6, and Bartlett's test of sphericity was significant (χ^2 (210) = 3618.74, $p < .05$). The items are correlated for further factor analysis.

The diagonals of the anti-image correlation matrix for all items were over .5, supporting the inclusion of each item in the factor analysis. Finally, the communalities were all above .3, further confirming that each item shared some common variance with other items. Given these overall indicators, factor analysis was conducted with all 21 items.

Table 3: Factor Analysis of Indoor Environmental Quality in Refurbished Kindergarten Buildings

Code	Items	Component				
		1	2	3	4	5
R8	Air movement	.826				
R7	Ventilation	.820				
R9	Freshness	.703				
R3	Amount of daylight	.612				.423
R17	Privacy	.540	.497			
R6	Temperature	.447				.394
R18	Immediate colleagues		.848			
R19	Management		.818			
R20	Workplace in general		.688			
R21	Outward appearance	.391	.532			
R12	Health		.465	.344		
R14	Attractiveness			.845		
R13	Colour			.830		
R15	Control over local environment			.404		
R11	Smell in the room				.758	
R10	Humidity level	.471			.566	
R1	Noise				.551	.352
R2	Electric lighting			.430		.554
R4	Glare level				.382	.544
R5	Distance to window	.479				.537
R16	Workspace					.516
KMO				.876		
Bartlett's Test of Sphericity				3618.742		
df				210		
Sig.				.000		

Principal components analysis was used because the primary purpose was to identify and compute composite coping scores for the factors underlying the short version of the occupants' perceptions. The

initial eigenvalues showed that the first factor explained 33.75% of the variance, the second factor 9.49% of the variance, the third factor 6.83%, the fourth factor 5.65% and the fifth factor 5.12%. This means that factors one to five have eigenvalues just over 1; each of the five factors explaining 60.83% of the variance was preferred because of its previous theoretical support.

Table 4: Total Variance Explained

		Initial Eigenvalues	
Component	Total	% of Variance	Cumulative %
1	**7.088**	**33.750**	**33.750**
2	**1.993**	**9.491**	**43.241**
3	**1.434**	**6.827**	**50.068**
4	**1.185**	**5.645**	**55.713**
5	**1.075**	**5.121**	**60.834**
6	.978	4.656	65.489
7	.888	4.228	69.718
8	.765	3.642	73.360
9	.670	3.191	76.551
10	.635	3.025	79.575
11	.612	2.914	82.489
12	.546	2.601	85.091
13	.480	2.287	87.378
14	.469	2.234	89.611
15	.465	2.212	91.823
16	.429	2.042	93.865
17	.387	1.843	95.709
18	.310	1.474	97.183
19	.222	1.055	98.238
20	.205	.977	99.215
21	.165	.785	100.000

The eigenvalues (Figure 7) on the scree plot leveled off after five factors, with an insufficient number of primary loadings and difficulty in interpreting the sixth or subsequent factors. There was little difference between the varimax and oblimin solutions, so both were examined in the subsequent analyses before deciding on an oblimin rotation for the final solution.

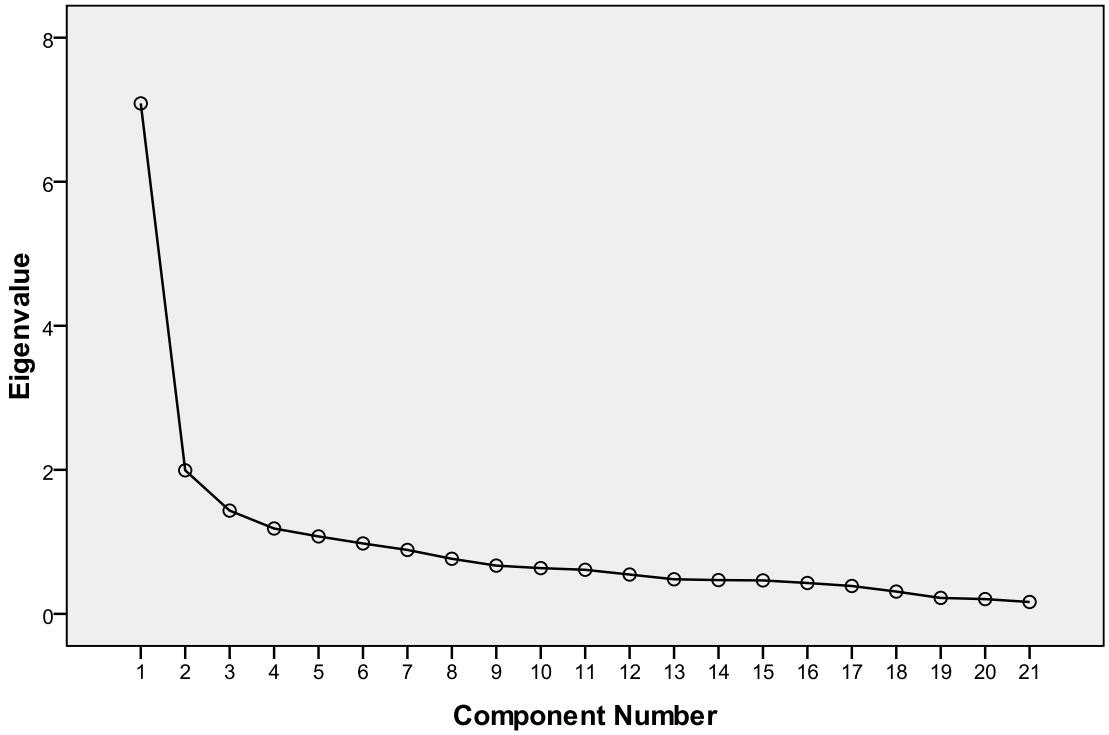

Figure 7. Factor Analysis Scree Plot

The factors were accordingly ordered and grouped by size sample, with interpretative labels suggested, as shown in Table 5.

Table 5: Variables Contributing to Factors

FACTOR 1-Air Quality			
1	.826	R8	Air movement
2	.820	R7	Ventilation
3	.703	R9	Freshness
FACTOR 2-General			
1	.848	R18	Immediate colleague
2	.818	R19	Management
3	.688	R20	Workplace in general
FACTOR 3-Appearance			
1	.845	R14	Attractiveness
2	.830	R13	Colour
3	.404	R15	Control over local environment
FACTOR 4-Intrusion			
1	.758	R11	Glare level
FACTOR 5-Workplace			
1	.516	R16	Amount of working space

4.4.1 Reliability analysis

Reliability analysis was conducted to ensure the validity and consistency of the construct items used for each variable (Masrom, 2007). Cronbach's Alpha is a reliability coefficient that points out all the items in the questionnaire that are positively correlated to one another. The acceptable coefficient is 0.6, and reliability over 0.8 is considered good (Sekaran and Bougie, 2009); the closer Cronbach's Alpha is to 1, the higher the internal consistency. It was important to ensure that the questions asked in the questionnaire are reliable and easy to understand by the respondents. Table 5 shows the application of Cronbach's alpha in this study.

Table 6: Reliability of Construct Variables

Constructs	Cronbach Alpha, α	Acceptability
Dependent Variable		
General	0.85	Good
Independent Variables		
Air Quality	0.93	Good
Appearance	0.87	Good
Intrusion	0.90	Good

Table 6 presents the coefficient alpha value for all the variables in this study. The α value for office in General (dependent variable) is .85, which is considered good. The independent variables, Air Quality (α=.93), Appearance (α=.87) and Intrusion (α=.90) are considered to have good reliability. Therefore, all of the dependent and independent construct variables are valid and reliable since the alpha values are greater than.6 (Sekaran and Bougie, 2009).

4.4.2 Scores for factors from the questionnaires

Analysis of variance (ANOVA) is applicable if the research has two groups or more to compare; it is a statistical method that yields values that can be tested to determine whether a significant relation exists between variables.

Based on the five factor scores generated, a further analysis on the differences between each factor in the questionnaire was carried out. Using SPSS, one-way ANOVA and t-tests were performed to

determine the statistical significance of differences among the means of the groups in five selected variables. Further analysis was carried out on the IAQ factor, as shown below and in Table 7.

a) Analysis one: Type of building

The questionnaire had five sub-groups based on building types, as detailed in Table 2.

An analysis of variance revealed significant differences at the 5% level in the Appearance [$F(4,403)=2.73$, $p= 0.03$] and Intrusion [$F(4,403)=2.67$, $p= 0.03$] factor score. On the other hand, there are non–significant differences at the 5% level in the Air Quality, General and Workplace scores. Post hoc analyses using the Tukey HSD for significance indicated that the average number of errors was significantly lower in the bungalow condition towards general and intrusion factors than in the other three factors.

b) Analysis two: Type of ventilation

There are two major groups of ventilation: natural (n=183) and air conditioning (n=221). The few hybrid/mixed ventilation systems were considered as air-conditioning, because most of the pre-schools turn on the air conditioning as early as 10 am, or whenever they felt the temperature increased in the building.

The t-test for independent samples revealed non-significant difference at the 5% level for other factors. This means that, there is little difference between the two types of the ventilation.

c) Analysis three: Work category

An analysis of variance revealed significant differences at the 5% level in Intrusion [$F(3,403)=4.9$, $p= 0.02$]. However, there were non-significance differences at the 5% level in the other factors. Post hoc analyses using the Tukey HSD for significance indicated that the average number of clerks had a higher opinion of intrusion than the “others” category.

d) Analysis four: Respondents Age

An analysis of variance revealed non-significant differences at the 5% level in all the factors, indicating that all age groups have the same opinion about the environmental factors.

e) Analysis five: Number of people in the building

An analysis of variance revealed significant differences at the 5% level in the Air Quality [F(5,403)=7.22, p= 0.00], Appearance [F(5,403)=2.43, p= 0.03] and Workplace [F(5,403)=4.81, p= 0.00] factors. Post hoc analysis using the Tukey HSD for significance indicated that the mean scored of group people in the building was lower than a workplace of 2 people in air quality and the workplace in general.

Moreover, Figure 8 explains the negative relation between the dissatisfaction/dislike levels of perception and the total hour staff spend in the building.

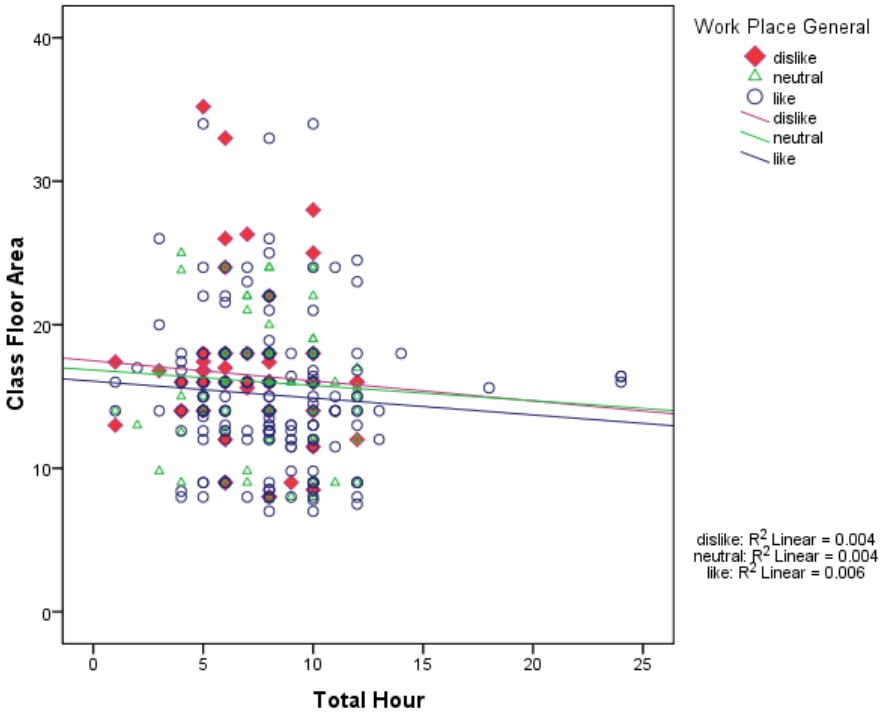

Figure 8: Scatter plot of total hours spend in the building and the class floor area with the perception of the building in general

f) Analysis six: Time spent in the building

The questionnaire had four sub-groups for the number of hours spent in the building each day.

An analysis of variance revealed significant differences at the 5% level in the General factor [F(4,403)=5.82, p= 0.00]. Post hoc analyses using the Tukey HSD for significance indicated that the mean score of the group spending 4-6 hours in the building was lower than that for those spending more than 10 hours there.

g) Analysis seven: Classroom floor area and space requirement

There were four sub- groups here: <10m^2(n=46), 10-20m^2(n=315), 20-30m^2(n=39) and >30m^2(n=4).

A one-way between subjects ANOVA was conducted to compare the effect of workplace/classrooms' floor area with the five factors of IEQ. There was a significant effect of floor area towards the classroom's external appearance at the p<.05 level for all four groups [F(3, 339) = 2.837, p = 0.04]. Post hoc comparisons using the Tukey HSD test indicated that the highest mean score was for classrooms with a floor area more than 30m^2.

Table 7. Analysis of Total Variance

SAMPLE	N	AIR QUALITY	GENERAL	APPEARANCE	INTRUSION	WORKPLACE
Building type	F_r	*0.77	*0.91	*0.03	*0.03	*0.51
Ventilation type NaV=183 AC= 221	t_1	**0.09	**0.80	**0.41	**0.06	**0.62
Work category	F_r	*0.72	*0.08	*0.80	*0.02	*0.86
Age	F_r	*0.07	*0.06	*0.10	*0.14	*0.82
Number of people in building	F_r	*0.00	*0.90	*0.03	*0.16	*0.00
Hours in building	F_r	*0.69	*0.00	*0.46	*0.17	*0.07
Classroom's floor area	F_r	*0.23	*0.11	*0.04	*0.69	*0.11
Space/person requirement (<2m^2/person) Not Complied with: 372 Complied with: 32	t_1	*0.14	*0.25	*0.14	*0.14	*0.45

F_r =F ratio Oneway Analysis of Variance, t_1 = t-test for independent sample
*p<0.05 **p<0.01

4.5 Multiple Linear Regression

The multiple linear regression was conducted to determine the variable best predicting the liking for the Workplace in general (R20). It was used to identify the extent of the influence of the independent variables (IVs) toward the workplace in general (DV) and to report on the proportion of the variance accounted by the model used in this study, the significance of the model used and the significance of the independent variables. Therefore, the independent variables chosen from the factor one: Indoor Air Quality were R7: ventilation, R8: Air Movement, and R9: Freshness. Moreover, the standardized β

values ascertained the extent of the effect of independent and dependent variables, and determined the relative effect, which are the independent variables with the greatest influence on the dependent variable.

Table 8. Multiple regression variables towards Workplace

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.442[a]	.195	.189	.887	.195	32.300	3	399	.000

a. Predictors: (Constant), R7, R9, R8
b. Dependent Variable: R20

Table 9. Independent variable

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	76.322	3	25.441	32.300	.000[a]
	Residual	314.268	399	.788		
	Total	390.591	402			

Tables 8 and 9 indicate the effect between the Indoor Environment Quality (IEQ) and the Workplace in general. The findings show that the value of R-squared for the Freshness, Air Movement and Ventilation (indoor environment elements) is 0.195. This means that 80.5% of the variation in the adult occupants' perception towards their workplace cannot be explained by Freshness, Air Movement, and Ventilation. This regression is significant at 0, $F(3,399)=32.3$, $p<.05$.

The adjusted 19.9% R-squared shows the strength of the model for this study. The standardized β values also explain the importance of the indoor environment factors in this study, and give a measure of the contribution of each independent variable to the model. A large β value indicates that a unit change in these independent variables has a large effect on the dependent variable.

Table 10 indicates that the Independent Variables have a positive relation, except for Air Movement (R8), towards the Dependent Variables. Ventilation (R7) has the highest significant correlation (0.23) with the Dependent Variables. The regression for Ventilation is positive, $t=3.87$, $p<0.00$. The study also found that Ventilation ($\beta=0.389$, $t=3.869$, $p<0.05$) is the most influential factor in determining the adult-occupants' perception towards the Workplace in general. Freshness ($\beta=0.236$, $t=4.128$, $p<0.05$) is another factor that significantly influences adult-occupants' perception towards the Workplace in general. However, Air Movement ($\beta=-0.03$, $t=-0.399$, $p=.69$) does not significantly influence the model.

Table 10. Coefficient and significant level for every independent variable towards workplace in general (R20).

	β	t	Sig.
R9(Freshness)	.236	4.128	.000
R8(Air movement)	-.030	-.399	.690
R7(Ventilation)	.286	3.869	.000

5. DISCUSSION

The vast majority of the 240 participating private kindergarten, 92.9% are based within buildings that were previously residential and there is a strong tendency for the use of Two-Storey Terraced Houses within the size range of 100-199m^2 of floor area. This may be a consequence of the availability of such properties or a reflection on their proximity to the population that they serve within residential communities. Two-thirds of the buildings are located on medium-local streets with moderate traffic flow less than 50m from the premises suggesting that the location tends to be similar for these types of premises. Surprisingly, within the sample buildings the vast majority of the classrooms (96.6%; N=711) identified did not comply with Uniform Building by Laws (UBBL) requirement of space per person in classrooms. This suggests that the conditions are more heavily occupied that envisaged by the UBBL, which has potential impacts upon perceptions IEQ.

Within the data from occupant survey the “Noise” factor was given the lowest satisfaction score, whilst the “Colleagues” factor was granted the highest satisfaction score. As most of the refurbished kindergarten buildings consist of only 4 to 7 staff members, it is perhaps not surprising that the highest satisfaction scores were given to the “Colleagues” and “Management”. The reason for that may be due to the strong bonds developed between the small teams of staff and management, and their relationship with pupils in the kindergartens, indicating a mutually beneficial interaction among them. The adult-occupants confirmed that the bright and cheerful colours of wall paint, as well as the decorative wall murals are very attractive to them and also to the pupils, hence, these were given the next highest satisfaction scores.

The adult-occupants noted external noise level as the most disturbing IEQ factor. The reason for this is most likely that majority of the refurbished kindergarten buildings are located in urban areas

where there is normally a high volume of traffic. Moreover, the internal noise level was referenced by the adult-occupants as quite disturbing during the teaching periods.

This group also gave less favourable satisfaction scores to the "Smell", "Humidity", and "Freshness". This is considered alongside the data relating to the proportion of rooms that fail to achieve the space requirements of the UBBL, which suggests that there is over-occupation or even overcrowding of classrooms. Overcrowding in classrooms which had previously been bedrooms (9 – 23 m^2) may contribute to breathing difficulties and a smelly environment. It is much harder for air to circulate freely in a crowded classroom, thereby making some students more likely to feel faint or suffer nausea. It would be especially unpleasant in these kindergartens, since Malaysia has an equatorial climate with high humidity throughout the year making the environment of classrooms even more uncomfortable. However, it was also noted that the other three air quality factors, "Air Movement", "Ventilation", and "Temperature" were given higher satisfaction scores suggesting that the issue is associated with the specific aspects of air moisture content and odour contaminants rather than being a general reflection on air quality and ventilation overall.

Daylight which is critical to the well-being of building's occupants was given relatively a high satisfaction score. The reason for this is likely to be that the refurbished kindergarten buildings in this study are located toward the core of the space to allow for the maximum daylight penetration. Moreover, the kindergartens use light-colored surfaces on walls and desks to reflect daylight around the space, which has been noted to have addition benefits in terms of user perception. Pleasant color schemes and the presence of coordinated art objects have potential impacts on occupants' satisfaction and well-being (Frontczak and Wargocki, 2011). Site observations indicated that the refurbished kindergarten buildings have pleasant indoor colors. In addition, the attractiveness of the indoor environment of the buildings was perceived to be improved by murals and other art objects. The Glare Level, Distance to the Window, Humidity, Noise and Smell were given the least scores implying their less important value from the adult-occupants' standpoint.

Overall, satisfaction levels were lower for buildings with higher numbers of occupants and it is clear that crowded buildings will result in an unpleasant environment, freshness, smell, ventilation and temperature of the building, and affecting the opinion on the workplace in general. There was a negative

relation between the dissatisfaction/dislike levels of perception and the total hour staff spend in the building. Surprisingly, the results for satisfaction level had a similar range, where time spent in the building also had a negative relation to the satisfaction level. In other words, the more time spent in the kindergarten building, the greater the satisfaction of the occupants. Nevertheless, for some occupants, more time spent in the building generated unpleasant feelings towards it. A similar result was found between the perception of the workplace and the class floor area. The mean score of the group spending 4-6 hours in the building was lower than that for those spending more than 10 hours there. This is due to the long time being exposed to the same environment, which might also affect the liking variable.

There was a significant effect of floor area towards the classroom's external appearance. The highest mean score was for classrooms with a floor area more than $30m^2$. The greater the floor area, the better the appearance the building will have. However, there is no significant relation between the space requirements per person and contribution to an unpleasant environment among the five factors determined earlier. Other variables caused discomfort to the occupants.

Analysis of the effect between the Indoor Environment Quality (IEQ) and the Workplace in general indicated that 80.5% of the variation in the adult occupants' perception towards their workplace cannot be explained by Freshness, Air Movement, and Ventilation. The study also found that Ventilation is the most influential factor in determining the adult-occupants' perception towards the Workplace in general. Freshness is another factor that significantly influences adult-occupants' perception towards the Workplace in general. Therefore, Freshness and Ventilation are considered as the two most significant indoor environment factors. However, Air Movement does not significantly influence the model.

This is related to the overcrowding in the building. Good ventilation ensures the comfort level and might improve the quality of the learning environment. The comfort level is related to IEQ performance (e.g. control of ventilation, temperature and lighting). Less air movement is needed because many of the learning activities in the building use plentiful supplies of loose paper. Hence, by controlling air movement in the classrooms distraction of pupils by papers flying around could be prevented.

6. CONCLUSION

This study examined the Indoor Environmental Quality (IEQ) of 240 refurbished kindergarten buildings in Malaysia. The four IEQ factors, namely "Colleagues", "Management", "Attractiveness", and "Colors" are considered as the most satisfactory factors from the occupants' point of view. The reason for the favorability of the first two factors is the small population of the studied kindergartens which results in a friendly environment where all personnel have a close relationship with each other and with the pupils. The reason for the popularity of the two latter IEQ factors is the cheerful color and use of art objects in the buildings which directly influence the mood and well-being of the occupants. Among other IEQ factors, "Daylighting" factor is also considered as an important factor. The occupants were pleased with the daylighting in the buildings, as the buildings allow for the maximum daylight penetration. The occupants referenced "Noise" factor, followed by "Smell", "Glare Level", and "Distance to window" as the least satisfactory features. The factor "Noise" was given the negative score due to the high external noise from the main roads, as well as, the internal noise in the small classrooms. The occupants were not also satisfied with the air quality in general, and therefore, they considered "Humidity", "Freshness", and "Ventilation" as the moderately low satisfying features in the buildings. The two influential factors for this dissatisfaction are the warmth and humidity of Malaysia weather, and also the overcrowding in classrooms resulting in low air movement and consequently unpleasant conditions in the classrooms. This study is in consistency with that of Frontczak and Wargocki (2011), who found that occupants feel dissatisfied with poor conditions and environment in buildings, such as extreme temperature and noise.

The attitude and perception of adult-occupants regarding the importance of twenty-one IEQ factors were ranked. Two IEQ factors, "Colors" and "Attractiveness", are ranked as the most important factors in workplace. The "Glare Level" and "Distance to the Window" were given the least scores implying their less important value from the occupants' standpoint. The factor analysis of IEQ of the kindergartens indicates that "Air Movement" followed by "Ventilation", "Freshness", and "Daylighting" are the most important IEQ factors of occupants' preference for their workplace. The analysis also identified the significant variables related to the demographic information and air quality, appearance, intrusion, and workplace in general. Findings show that there is no significant difference

between natural ventilation and air conditioning in the refurbished kindergarten buildings. There is also no significant difference between age group and air quality, appearance, intrusion and workplace in general. For the work category, this study indicated that the perception of clerks is higher in intrusion, compared to teacher assistants and housekeepers. There is also a significant difference between the number of people in the building, time spent in the building, classroom floor area, and attitudes to the workplace in general.

There are very limited studies in the literatures addressing IEQ conditions in kindergartens which are converted from other buildings. This present study provides knowledge about typical IEQ conditions in refurbished kindergarten buildings in Malaysia. Moreover, it presents an assessment of IEQ satisfaction and requirements in the workplace from the occupants' standpoint in the kindergartens. Overall, the results of this study confirm that there is a general positive view of satisfaction in regard to the IEQ factors in the refurbished kindergarten buildings in Malaysia.

The findings of this study not only help to identify the problems concerning the indoor environmental conditions of refurbished kindergarten buildings in Malaysia, but also suggest useful information in regard to satisfaction of occupants in these buildings. The conditions of children in refurbished kindergarten buildings should be given a priority as they are more sensitive and susceptible to the unfavorable environmental conditions. This study is therefore of value in providing a practical benchmark for designers, local authorities and lawmakers who are involved in conversion of buildings' usage.

Most refurbished kindergarten buildings in Malaysia were found not to comply with minimum space regulations concerning children, teachers and other staff, leading to uncomfortable conditions. It is suggested that the authorities take this issue into account and provide sufficient space for the occupants of the building with the cardinal focus on comfort of occupants. Because the noise level was considered relatively high in majority of refurbished kindergarten buildings in this study, it is recommended that the authorities select those premises for the purpose of conversion into kindergartens which are quite far from the main roads. Consequently, at low levels of external noise, pupils can better concentrate on their activities. Moreover, the results from the survey found that the occupants are dissatisfied with the air quality of the buildings, especially the unpleasant odors that come from the use

of the toilet facilities. Therefore, it is essential for the authorities to consider the location of classrooms and their distance to the toilet facilities when the housing or commercial buildings are converted to the kindergarten's usage. Since the occupants were satisfied with the existing room's wall color and also they gave the highest liking score to the color and attractiveness of the kindergartens, the authorities should keep in mind the importance of color schemes and art objectives in interior environment and their influence in comfort and well-being of occupants.

Future research includes addressing cultural habits of the occupants, as well as, the effects of outdoor conditions on IEQ in refurbished kindergarten buildings in Malaysia.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the financial support of the High Impact Research (HIR) grant, no. UM.C/625/1/HIR/ASH/013 established by the University of Malaya

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