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Indoor Air Quality (IAQ) Acceptance in Universiti Tenaga National

Iman Asadi* and Ibrahim Hussein

Universiti Tenaga Nasional Malaysia

Corresponding author

KEYWORDS

Indoor air quality, carbon dioxide concentration, air conditioned building, occupant sensation, indoor temperature

A B S T R A C T

Most people spend 90 percent of their lives indoor, therefore a good indoor air quality is important for occupant health and comfort. In this study, measurement and analysis of indoor carbon dioxide (CO_2) concentration and other physical parameters are used to understand the indoor air quality (IAQ) acceptance of occupants of air conditioned buildings in Universiti Tenaga Nasional (UNITEN). The purpose of this study is to measure the CO_2 concentration, indoor temperature, relative humidity and air velocity in buildings and evaluate the occupants sensation through objective and subjective measurements. Offices and student study areas have been selected as two main sampling areas.The results of IAQ assessment from 154 occupants (44 female and 110 male) from 10 offices, 3 classrooms, one computer laboratory and one library area showed that most mutual sensation votes for both staff and students are within the neutral CO_2 concentration and the indoor air quality is acceptable for 83.3% and 90.0% of occupants in offices and student study areas respectively. In this study the occupants sensation for CO2 concentration in different buildings of UniversitiTenagaNasional has been measured and the neutral votes obtained

Introduction

Most people spend about 90% of their lives inside buildings(Sarbu and Sebarchievici 2013). Indoor air quality (IAQ) is closely related to the comfort and health of occupants.IAQ is characterized by focusing on chemicals, particles, and biological elements in the atmosphere and on surfaces immediately nearby the air in a space**.** It is also characterized according to the way which it is perceived by the occupants, even though these realization of air quality may not relate directly to the possible health effects resulting from the quality of indoor air**.** Indoor air pollutants also directly relates to human physiology.

ASHRAE Standard 62.1, defines acceptable indoor air quality as air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities, and with which a substantial majority (80% or more) of the people exposed do not express dissatisfaction. Perceived air quality is also influenced by thermal sensations and indoor moisture.

Fang conducted research which concentrated on parallel measurements of air quality, air temperature and also humidity, and found that ambient temperature and also humidity in air have a significant impact on the realization of air quality(Fang, Clausen et al. 1998).IAQ is one of the top five environmental risks to public health and Poor indoor air quality is also related to sick-buildingsyndrome(SBS)(Fisk 2000; Mendell, Fisk et al. 2002; Kilabuko, Matsuki et al. 2007).Based on a report of the Center for Disease Control and Prevention (CDC) in USA, the risk of health such as asthma, that are activated by indoor air quality problems, have enlarged by 42% between the year 1982 and 1992(Singh 1996). Therefore, indoor air should have enough quality so that contaminants in the air are not at harmful concentration level and most people feel satisfied with it. This paper presents the results of a field study carried out to determine the IAQ acceptance of occupantsin offices and student study areasin UniversitiTenagaNasional. The study was carried out through physical parameter measurements and subjective measurements via survey. The main physical parameter measured as an important IAQ index is CO_2 concentration. In order to analyze the overall acceptance of indoor air quality, other parameters measured includes indoor temperature, relative humidity and air velocity.

Objective measurement

In this study, objective measurements have been carried out withCO_2 concentration as an important index of IAQ. The field study was conducted in UniversitiTenagaNasional (UNITEN) Putrajaya Campus, which is located in JalanIkram-UNITEN, Kajang, Selangor. There are several buildings in this university.The offices, and student study areas which were selected for physical measurements are located in administration building, College of Engineering (CoE), College of Information Technology (CoIT), College of Foundation and General studies (CFGS), IT and multimedia building(ITMS) and library.These buildings are shown in Fig.1.Apart from CO_2 concentration (ppm), indoor temperature (˚C), relative humidity (%), air velocity (m/s) were also measured to analyze the overall IAQ acceptance in UNITEN buildings. Measurements were carried out for 15 minutes for each sampling.The portable HAZSCANNER™ GB-2000 was used to measure CO2 concentration, air temperature, air velocity, and also relative humidity. This equipment is shown in Fig.2. Five offices in different levels of administration building (Admin), three offices in different levels of CoE one office in CFGS andoneoffice in library have been considered. The number of measurement samples is equal to the number of occupants. Two classrooms in CoE,one classroom in CoIT, ground floor of library and computer laboratory of ITMS were selected as student study areas for the study.The number of measurements taken depends on the size of the area. The average values of these measurements during the 15 minutes period were recorded.

Subjective measurement

Subjective as well as objective assessments of indoor air conditions were completed by 154 occupants (44 females and 110 males) from 10 typical air conditioned offices and 5 typical student study areas. Questionnaires for the subjective evaluation of observed IAQ were presented to the survey subjects. Semantic differential scale and dichotomous scaleare common tools which are used in the subjective assessment of indoor environmental conditions(Mui and Wong 2007; Wong, Mui et al. 2008).In this research, a semantic differential scale r_1 was employed to record the occupant responses. As a mean to estimate response validity, scale r_1 indicates “very bad, bad, less bad, neutral, less good, good, very good” for IAQ. Each answer has a value for analyzing data from {-3}to {+3}. The mean vote is calculated by considering these values and number of occupants.The occupants’

acceptance of the observed indoor air quality were also studied with a two-point dichotomous assessment scale r_2. This scale was used for a direct feedback or acceptability with the question "Is the air quality acceptable to you?" The ranks '{1} acceptable' and '{0} unacceptable' were used.Both scales were easily comprehensible and, therefore, fast responses could be made during the survey. In orderto confirm the validity of those answers, each respondenthad to use both scales for the subjective assessment.

Fig.1 different building in Uniten

Fig.2 HAZSCANNER™ GB-2000

Results

The votes of occupant sensations against CO_2 concentration were plotted from the data obtained and are shown in Fig.3 and Fig.4. The neutral votes of CO2 concentration in offices and student study areasdetermined by regression analysis of the data obtained are 606.4 ppm and 1046.9 ppm respectively. The neutral votes for the student study areas seem to givea more accurate results because of a better correlation coefficient. Furthermore, the number of occupants are also higher and the sensation votes are all below 1000 ppm.The measured CO_2 concentration,indoor temperature, relative humidity and air velocity are shown in Tables1 and 2. The results obtained showed that the indoor air quality is

acceptable for 83.3% and 90.0% of occupants in offices and student study areas respectively.The overall IAQ sensation of occupants in offices and student study areas are shown in Fig. 5 and Fig. 6 respectively. The measured CO_2 concentration in the UNITEN's buildings were compared with the existing Malaysian standard for indoor air quality, which limits the acceptable range of below 1000 ppm (M.A Sulaiman2013).The comparison between the results of this study and the Malaysian standard are shown in Fig. 7 and Fig.8.

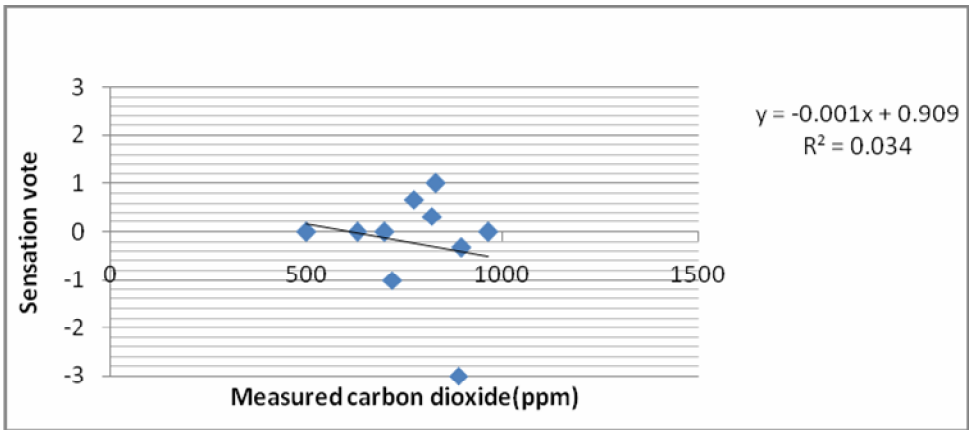

Fig.3 Regression analysis of IAQ sensation votes in offices

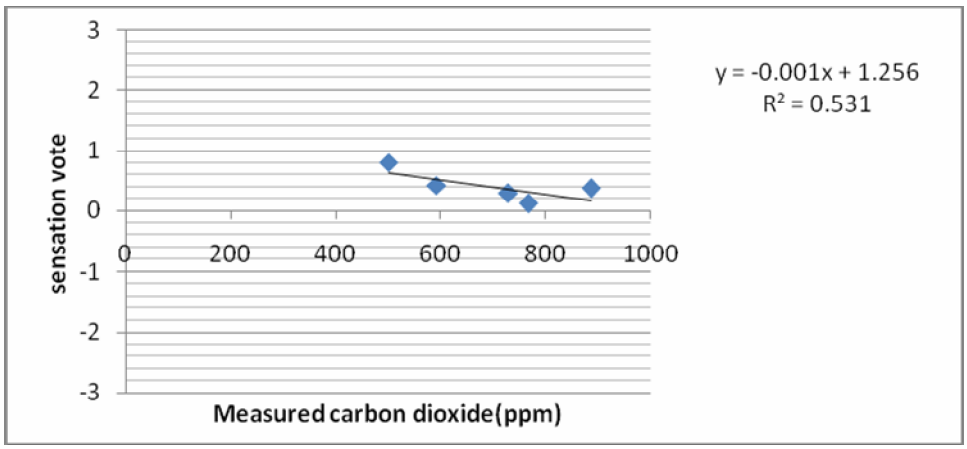

Fig.4 Regression analysis of IAQ sensation votes in student study area

Table.1 Descriptive summary of measured variables in offices

Descriptive statistic	T(℃)	Va (m/s)	RH (%)	CO2	IAQ vote	Mean
Mean	23.286	0.09	67.157	772.72	-0.233	
Min	23	0	59	501.4	-3	
Max	24.35	0.15	75	964.2	1	
standard deviation(SD)	0.423	0.039	4.856	138.711	1.111	

Table.2 Descriptive summary of measured variables in student study areas

Descriptive statistic	T(°C)	Va (m/s)	RH (%)	CO2	IAQ vote	Mean
Mean	22.598	0.12	70.114	694.8	0.4	
Min	22.16	0.1	61.8	500	0.115	
Max	23	0.2	78.5	886	0.806	
standard deviation(SD)	0.341	0.04	6.093	135.183	0.228	

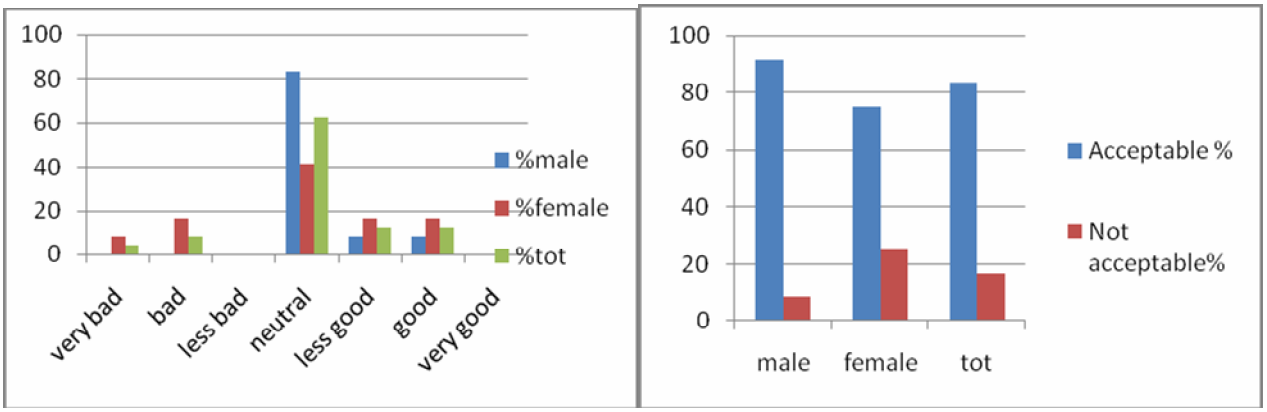

Fig.5 IAQ sensation in offices

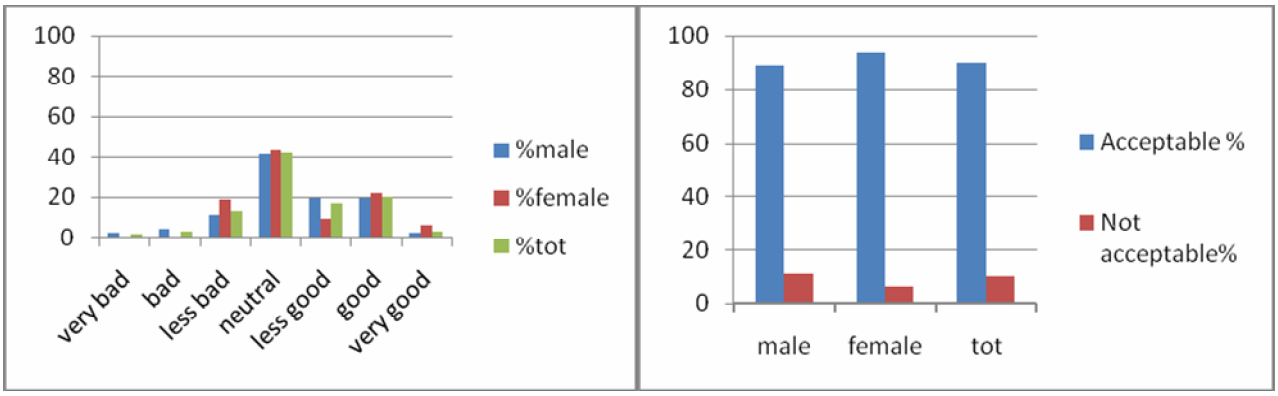

Fig.6 IAQ sensation in student study areas

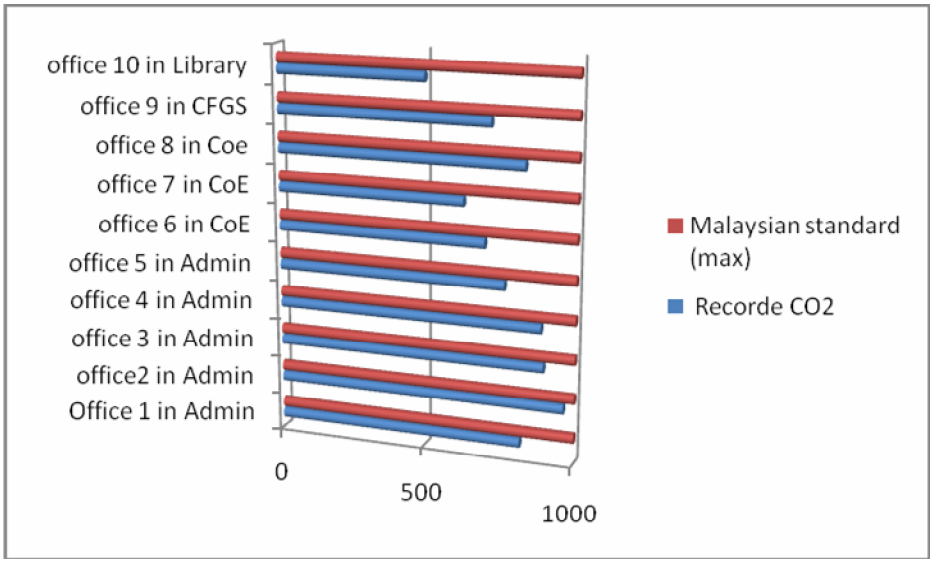

Fig.7 CO_2 concentration in offices

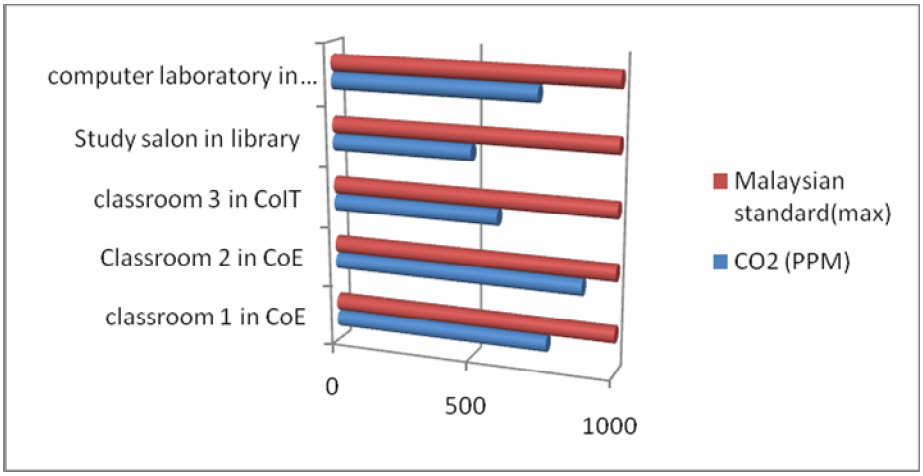

Fig.8 CO2 concentration student study

Conclusion

In this study the occupants sensation for CO2 concentration in different buildings of UniversitiTenagaNasional has been measured and the neutral votes obtained are 606.4 ppm and 1046.9 ppm in offices and student study areas respectively. Indoor temperature, relative humidity and air velocity are also measured to gauge the overall IAQ acceptance of occupants. The results obtained showed that the overall indoor air quality is acceptable for 83.3% and 90.0% of occupants in offices and student study areas respectively.

The amount of CO2 concentration is in the acceptable range and within the limits of the Malaysian standard, and most occupants are satisfied with the indoor air quality. This study could be extended to include buildings in different part of Malaysia and the results obtained could be used to form guidelines for building owners and managers in Malaysia.

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