

AWARENESS STUDY OF PASSIVE VENTILATION SYSTEM IN OFFICE BUILDINGS

CHUA Kheng Ee^{1, a} and CHAN Siew Chong^{2, b}

¹⁻² INTI International University, Faculty of Engineering and Quantity Surveying

Corresponding author: ^atrinichua@hotmail.com, ^bsiewchong.chan@newinti.edu.my

ABSTRACT. Heavy dependence onto artificial air-conditioning systems to control the temperature of indoor environment of office buildings has been creating serious global environmental issues due to its nature of high energy consumption. Many research works show that passive ventilation systems may be one of the effective strategies to overcome this key problem through of the approaches to integrate the passive ventilation designs with the building design, such as building orientation, proper shading, thermal insulation, air well design, window selection and others. This research is thus focused onto identifying the awareness of passive ventilation system application in office buildings, and this further leads to compare the extent of awareness of this approach based on two different groups of office users. The research tool used in this study is Descriptive Statistics which consists of Mean-Standard Deviation Analysis and Priority Ranking based on Average Index. The results show that both groups of users have low awareness level of Passive Ventilation System application in office buildings, however Group A show high level of acceptability than Group B. Thus, it is important for the future policy makers to intensify the implementation of Passive Ventilation approach to increase the awareness level of the users in the near future.

KEYWORDS: Natural Ventilation, Passive Ventilation, Passive Design, Office Building and Energy Consumption.

1. INTRODUCTION

Natural ventilation can be defined as a strategy to supply outdoor air into the indoor environment for the purposes of cooling down the temperature, while passive ventilation can be considered as part of natural ventilation approach to simultaneously enhance indoor air quality of the building, and at the same time, reduce ventilation energy consumption. Compare with mechanical ventilation, natural or passive ventilation strategies are not widely used, however, some studies have shown that there are fewer symptoms of the building occupants in natural ventilated buildings if compared to mechanical ventilated buildings, and thus, reducing the rate of absenteeism and medical costs, and also further increase the work productivity [1-2].

However, since the global and environmental issues of high energy consumption due to heavily relying on artificial ventilation systems is becoming serious in most of the countries, and air conditioning contributes the most significant of energy use portion, thus immediate actions should be taken to reduce energy use. One of the possible alternatives is to promote passive ventilation especially in office buildings. According to Al-Homoud's study [3], the findings shows that the

usage of air-conditioning is overloaded due to long working hours within air-tight environment. Lien and Ahmed [4] further point out that most of the people spends 87% of their lifetime within a building or about 6% in enclosed vehicles where all these environment is fully enclosed which results poor air circulation, and therefore, artificial ventilation systems are needed to sustain the air quality. This situation becomes more significant in Malaysia which in most situations the indoor air temperature is above comfortable temperature of 24 C.

In this study, the research focus is aimed to investigate the possibility of promoting the passive ventilation system, and identify the acceptability level of applying passive ventilation within office environment.

2. LITERATURE REVIEW

Building ventilation becomes one of the important contributors in sustaining an acceptable indoor air quality. Principles of good ventilation is to allows sufficient entry of fresh air to replace excessive heat and polluted indoor air, and basically Natural Ventilation which relies on the wind and thermal buoyancy as driving forces has been playing this role well, and thus, it is part of the cooling techniques in building technology to achieve the desired thermal comfort level and also to eliminate unwanted contaminants in the air [5].

Air movement such as air velocity, related humidity level and other factors play an important role in enhancing the effectiveness of ventilation. In order to optimize the performance of ventilation system, the building designers must consider all the relevant factors, such as building forms, building orientations, opening sizes during the pre-construction stages as these strategies and design factors may affect the performance of ventilation in sustaining the thermal comfort levels and indoor air quality [6].

This research study focuses onto office buildings which are normally the main energy consumers in built environment as most of the buildings are designed either with overestimated energy usage or inappropriate energy consumptions by the consumers [7]. Basically, most of the Malaysians' working hours are not limited to 8 hours per day, as it might be longer as over time, and thus, the indoor environment has been over cooled [3]. Besides that, frequent usage of modern technology which results in increasing internal heat gain also increase the demand of indoor cooling. According to Ismail [8], it is found out that air conditioning occupies the highest portion of energy usage in office buildings, 55-65% compared with 25-35% of lighting and 2-6% of lifting systems.

Thus, there is huge potential to improve its performance through energy savings with passive ventilation. There are a few office buildings in Malaysia have been designed and adopted the passive designs strategies to promote the concepts of energy efficiency, such as Low Energy Office in 2005 [9-10] and Malaysian Green Technology Centre in 2007 [7].

These strategies can be classified into building structural designs, such as: Air well allocation and window openings [11]; and passive cooling methods, which include: Insulation materials [12], glazing types [13], colours of building envelopes [14], shading effects [15], and water features [16].

According to James' et al research findings [17], he highlights that natural ventilation is able to minimize operation cost compared with mechanical ventilation and it does not have power failure issues. BRECSU [18] further show that natural ventilated offices in United Kingdom are able to save about 14 kWh/m² to 41 kWh/m² of energy used for cooling annually, although this may heavily depend onto the temperature and humidity conditions of external environment [19].

Furthermore, natural ventilated working environment has higher productivity levels and less sick building symptoms compared with mechanical ventilation systems [20]. This is further proven by Wong et al [21] whose findings shows that frequency of sick building symptoms incidents are higher in air-conditioned ventilated buildings as the CO₂ concentrations in these working environment are not only affect human health but also job performance or workers' productivities [22-23]. Besides that, natural ventilation is able to save initial cost and space requirement for ventilation design if compared with mechanical ventilation. The rate of initial cost savings may sometime up to 35% to 45% of the total construction cost, and in some occasions, the indoor office space requirement can be saved up to 20% to 40% of total volume of the building which are normally occupied by mechanical ventilation system such as fans, air conditioner system and so on [19].

With all these supporting facts from local and overseas researches, a local office building was selected as case study in order to collect the feedbacks of the building users in order to justify the effectiveness of natural ventilation within office working environment.

3. RESEARCH METHODOLOGY

Since the aim of this study is to understand the extent of awareness in using natural ventilation within indoor working environment among the officer users, thus Questionnaire research approach is selected in order to collect subjective variables and convert into objective and measurable numerical scale for further analysis. The respondents were divided into Mid Valley working group (Group A) and INTI International University working group (Group B), as this campus is referred as the main case study in this research.

The data collected from both respondent groups are compared to justify the consistency of variance between groups, and further evaluate the functions of natural ventilation within indoor working environment for this case study. Non-probability sampling approach is used for this study, and the sampling sizes for both Group A and B are 50 and 30 respectively.

There are 12 questions in the questionnaire and all of the questions are closed ended. Natural ventilation design strategies referred are mainly based on the INTI IU's, and thus, the data generated is to determine whether there is any differences of perception and understanding of integrating natural ventilation strategies for office working environment between these two groups.

Descriptive statistics method is used to analyze the data collected and presented in percentage and graphical formats. Further evaluations were justified through Average Index which ranks the priority or preference of respondents onto certain technical issues which are much related to the research topic.

4. FINDINGS AND DISCUSSION

Based on the data listed in Table 1, basically more than 80% of the targeted respondents were within the productive age group, which fell in 20-30 and 31-40 age range for both Group A and B, and are considered below the retirement age. In terms of gender, both groups are quite well balanced. Overall this data is quite valid for analysis and it is not bias to certain specific dimension.

Table 1 Background of Sample

Group	Age Group	Gender
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	20-30	31-40	41-50	>50	Female	Male
A	26 (51%)	13 (25%)	10 (20%)	2 (4%)	30 (59%)	21 (41%)
B	14 (47%)	15 (53%)	0 (0%)	0 (%)	19 (63%)	11 (37%)

In Table 2, more than 80% of the respondents in both groups did agree that mechanical ventilation systems consume higher energy consumption compared with passive ventilation systems, and this means that they are aware of the functions of passive ventilation within office environment, which shows that more than 50% of respondents in respective groups.

Table 2 Level of Awareness of Respondents onto Ventilation Systems and Energy Consumption

Group	Awareness of Passive Ventilation		Higher Energy Consumption	
	Yes	No	Mechanical	Passive
A	65%	35%	98%	2%
B	53%	47%	83%	17%

However, if compared with the usage of passive ventilation in both locations, it is found that both respondents seldom have opportunities to apply these ventilation strategies in both working environment, as shown in Table 3. In other words, both office buildings still heavily depend on the mechanical ventilation systems to monitor the indoor thermal performance.

Table 3 Frequency of Passive Ventilation Usage in Office Buildings

Group	Often	Sometime	Never	No Idea
A	2%	25%	73%	0%
B	0%	27%	57%	17%

The root causes of low level application of Passive Ventilation in office buildings, based on the findings shown in Table 4, are mainly due to lack of public awareness and also relying heavily onto the mechanical ventilation system, and this may further lead to high perceptions of lack of effectiveness of passive ventilation systems.

Table 4 Root Causes of not using Passive Ventilation

Group	Lack of Public Awareness	Relying heavily on Air-conditioning Systems	Lack of Effectiveness	Lack of Knowledge
A	75%	67%	39%	0%
B	67%	77%	77%	0%

However, as shown in Table 5, both groups suffer from very cold and cold issues in both working environment, and this means there are overloaded air conditioning problems in current office buildings, and thus, it provides opportunities to further reduce mechanical ventilation systems and promote passive ventilation systems in the future.

Table 5 Thermal Comfort Levels in Office Buildings

Group	Very Cold	Cold	Neutral	Hot	Very Hot
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A	51%	41%	6%	0%	2%
B	33%	47%	13%	7%	0%

Refer to Table 6 below, the desirability of both groups onto the passive ventilation system application in office buildings further strengthens the potential usage of this ventilation approach in the near future although Group A shows more than 50% of respondents express their agreement, compared with only 33% in Group B. Thus more promotions are needed to encourage the building designers and also the users to optimize the usage of passive ventilation systems in office buildings.

Table 6 Desirability of Passive Ventilation Usage in Office Buildings

Group	Yes	No
A	57%	43%
B	33%	67%

5. CONCLUSION

Based on the findings from this study, this study has also shown that the respondents are aware and ready to accept passive ventilation or known as natural ventilation to enhance their indoor working environment, and thus it can be concluded that this ventilation approach has certain potential to expand its usage in office buildings within the local context. However, more encouragement and promotion are needed to integrate the building design and the surrounding environment in order to ensure the owners and users are confident to apply this ventilation approach in their properties in order to improve the indoor air quality and also reduce the energy usage in the near future.

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