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Satisfaction and perception of residents with bioclimatic design strategies – A discovery from racial and ethnic perspective

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Abstract

A satisfaction and perception survey was carried out to assess the effects of recent adoption of bioclimatic design strategies in influencing the residents' comfort levels and the appropriateness of an old building to meet the needs of contemporary life. This residential building is located in Kuala Lumpur and was recognised as a residential college building with the most considerate implementation of bioclimatic design strategies, particularly in terms of the daylighting and natural ventilation. As relying on 95% confidence level and ±5% margin of error from the overall population, a total of 266 responses retrieved were fully supplied by the respondents. The majority of respondents are satisfied and feel comfortable with regards to all performance indicators including the architectural elements, visual comfort, thermal comfort and indoor air quality. Numerous differences were discovered by comparing the responses among the race and ethnic groups, obviously on visual comfort, thermal comfort and indoor air quality, the usage pattern of windows and ceiling fan, and thermal sensation which was based on 7 point of scale. As conclusion, the bioclimatic design strategies including daylighting and natural ventilation at an old residential building are still appropriate to meet the needs of contemporary life. However, there is still room for improvement, especially on the acoustic. The racial and ethnic composition considerably influence the satisfaction and the perception level of respondents and these aspects should be highly considered in implementing the improvement measures to ensure the comfort level of the room.

Keywords: bioclimatic design, ethnic, racial, residential building, survey.

1. Introduction

The residential college building is a multi-residential building which provides accommodation for university students. This building is also referred as a hostel which contains leisure areas, lounges, meeting rooms and laundry facilities (Jamaludin, 2014). Dayasari Residential College (DRC) established in 1966 with 18,212.51m^2 of total floor area. This residential college is low-rise, naturally ventilated building and able to accommodate 847 residents at one time. The building arrangement is based on the internal courtyard arrangement that encourages various implementations of bioclimatic design strategies, especially under the daylighting and natural ventilation conditions (Jamaludin, et al., 2011).

Bioclimatic elements in buildings were introduced by Olgyay during 1950s and were developed as a process of design during the 1960s; which included the disciplines of human physiology, climatology and building physics (Olgyay, 1963). The bioclimatic design system creates some internal conditions of comfort by using natural energy sources and sinks; without the use of any electromechanical devices or systems (Yeang, 2008; Hyde, 2000). Therefore, the system is seen as able to reduce the operating costs, enhance building marketability, reduce potential liability from indoor air quality problems and increase occupants' performance and productivity (Tiyok, 2009).

The building's orientation to the sun path of DRC is north-south that reduces the glare and the thermal effects inside the rooms (Ahmad, 2008). At the west-east orientation, there are only service areas, such as toilets, bathrooms, stores, staircases and balconies. The internal courtyard provides daylight and natural air in the corridor and staircase area whereas inside the room daylight and natural air can be obtained through the transom on top of the entrance door and the wall. DRC was designed with glare protection and adjustable/fixed opening options. There are two types of windows with tinted glasses, centre pivot and awning. The window to wall ratio (WWR) is quite big, 0.66, while the window area is 6.41m^2. The combination of operable window and transom on top of the entrance door and the wall forms cross-flow/two sided ventilation (Tantasavasdi, Srebric and Chen, 2001). The presence of the wall opening in the room creates a wind pressure inside the room. In order to produce significant shadow effects to the rooms, there are large horizontal overhangs along the window in each room.

2. Research Methodology

The survey done by Jamaludin, et al. (2014) have been adapted to restructure the questionnaires. The questions have been improved to obtain a clearer picture of satisfaction and perception level of the residents towards the recently implemented bioclimatic design strategies. The questionnaires use a Likert Scale format where each number generally responds to a specific scale as listed below,

- -2: very poor/not at all/very uncomfortable/much decreased/too dark/very dissatisfied/ very noisy,
- -1: poor/slightly/uncomfortable/decreased/dark/dissatisfied/noisy,
- 0: fair/moderate/neither/no changes,
- +1: good/very/comfortable/increased/bright/satisfied/quiet,
- +2: very good/extremely/very comfortable/much increased/too bright/very satisfied/ very quiet.

ASHRAE 7 point of the thermal sensation scale has been adopted in the further questionnaires of thermal comfort (Singh, Mahapatra and Atreya, 2011). The scale ranges from -3 to +3 where, -3: cold, -2: cool, -1: slightly cool, 0: neutral, +1: slightly warm, +2: warm, and +3: hot. Further survey was done by focusing on the usage pattern of the windows and ceiling fan. The questionnaires were distributed to all residents with the minimum number of feedbacks and with reliance on 95% of the confident level and ±5% margin of error from the overall population at each residential college. A simplified formula introduced by Yamane (1967) was used to calculate the sample sizes,

$$n = N / 1 + N (e)^2$$

where, n is sample size, N is the population size and e is the level of precision. In this study, the level of precision is 0.05. All the collected questionnaires were analysed statistically by using a statistical software package.

3. Results and Discussion

The results of the satisfaction and perception survey of residents at DRC are presented in Table 1. According to the percentages, the majority of respondents were experiencing a satisfactory level of comfort in all performance indicators, except for the acoustic elements. About 50.2% of respondents claimed that the general room and residential building layout which is the internal courtyard with open corridor were 'good'. Meanwhile, 49.8% agreed that the rooms had fulfilled their needs very much.

Table 1: The result of satisfaction and perception survey

The performance indicators		Likert scale / *Residents' responses (%)*				
		-2	-1	0	+1	+2
Architectural elements	The general room layout	*1.5*	*7.5*	*27.2*	*50.2*	*13.6*
	The residential building layout	*0.4*	*8.7*	*28.7*	*50.2*	*12.1*
	The adequacy of room in fulfil the needs	*1.1*	*11.4*	*25.5*	*49.8*	*12.2*
	The overall quality of the residential building	*1.1*	*6.0*	*28.7*	*52.1*	*12.1*
	The overall comfort level of the room	*0.8*	*4.5*	*29.1*	*53.6*	*12.1*
Visual comfort	The adequacy of daylighting in the room	*4.2*	*12.0*	*34.4*	*40.9*	*8.5*
	The overall quality of daylighting in the room	*1.5*	*7.7*	*28.8*	*48.5*	*13.5*
Thermal comfort & IAQ	The thermal comfort of the room	*3.4*	*11.7*	*29.7*	*43.6*	*11.7*
	The ventilation & IAQ of the room	*1.9*	*13.4*	*29.8*	*46.2*	*8.8*
Acoustic comfort	The noise/vibration level in the room	*2.7*	*15.6*	*41.6*	*33.6*	*6.5*

The majority of the residents which were represented by 52.1% felt 'good' about the overall quality of the residential building and 53.6% of respondents were 'comfortable' with the overall condition of the room. Regarding the visual comfort aspects, the majority of respondents (48.5%) were 'satisfied' with the overall quality of daylighting in the room. They claimed that the adequacy of daylighting in the room was 'bright' (40.9%).

Under the thermal comfort and Indoor Air Quality (IAQ) elements, the majority of respondents felt 'good' with both indicators, which are the thermal comfort in the room (43.6%) and the ventilation and IAQ of the room (46.2%). We noted that 59.7% of respondents were highly reliant on the ceiling fan at the highest speed of five (50.2%), rather than natural ventilation through the opening of windows in order to promote air circulation and movement inside the room, as presented in Table 2.

Table 2: The usage pattern of windows and ceiling fan

	Residents' responses (%)						
The frequency of ceiling fan usage in a day	Never	Rarely	Sometimes	Frequently	Every time		
	0.4	*3.1*	*10.9*	*26.0*	*59.7*		
The fan speed is often used	One	Two	Three	Four	Five		
	0.4	*2.7*	*17.1*	*29.6*	*50.2*		
The frequency of the windows is kept open in a day	Never	Rarely	Sometimes	Frequently	Every time		
	18.3	*14.8*	*21.0*	*30.4*	*15.6*		
The reason for not opening the windows	Insect	Safety	Rain	Dust	Privacy	Monkey	Others
	3.4	*16.1*	*6.3*	*9.8*	*20.5*	*38.0*	*5.9*

Further survey on the usage pattern of windows and ceiling fans at DRC revealed that the 'monkey' (38%) became the main reason for the residents to not open the windows, which was then followed by 'privacy' (20.5%), 'safety' (16.1%), 'dust' (9.8%), 'rain' (6.3%), 'others' (5.9%) and 'insect' (3.4%). However, some of the residents are still keeping the windows 'frequently' open (30.4%). Comparatively, the insects were the main reason why residents did not open the windows of residential buildings in the hot-humid climate of Malaysia (Kubota, Chyee and Ahmad, 2009).

The level of acoustic comfort is not very clear when the majority of respondents who were represented by 41.6% had voted 'neither' for the noise/vibration level in the room.

Regarding thermal comfort elements, a detailed survey has been done by adopting thermal sensation votes on ASHRAE 7 point sensation scale, which ranges from -3 to +3. The majority of the respondents, 39.3% claimed to have been feeling 'neutral', as presented in Table 3.

Table 3: Thermal sensation votes

ASHRAE 7 point sensation scale / *Residents' responses (%)*						
-3	-2	-1	0	+1	+2	+3
Cold	Cool	Slightly cool	Neutral	Slightly warm	Warm	Hot
0.4	*7.0*	*8.7*	*39.3*	*25.2*	*16.5*	*2.9*

Further statistical analysis was done by comparing the percentage of respondents with regard to race and ethnicity. Numerous differences were discovered by comparing the responses among the race and ethnic groups, obviously on thermal comfort and indoor air quality, visual comfort, the usage pattern of windows and ceiling fan, and thermal sensation, as presented in Figure 1 to 3. The dissimilarities of beliefs, traditions, and ways of life influence the behaviour and thermoregulatory responses (Katsuura, et al., 1993; Chung and Tong, 1990; Yang and Wang, 2013). The majority of the Chinese and 'Other' respondents rated one notch lower as compared to the overall rate (Table 1) in some parts of the elements. The majority of Chinese respondents claimed that the adequacy of daylighting in the room was 'neither (adequate nor inadequate)'. Whilst, the usage pattern of windows was quite confusing when the majority of Chinese respondents voted 'sometimes' and 'never' for the frequency of the windows being kept open in a day and the time the windows has are always open in a day, respectively. For 'Other' racial and ethnic groups, the majority of them claimed that the residential building layout, adequacy of daylighting, overall quality of daylighting were 'fair'. The safety, rain, dust, privacy, and the existence of wild animals like monkeys become reasons for 'Other' respondents for not opening the windows due to the equal percentage for each reason cited (20%).

The majority of the Indian respondents rated one rate higher than the overall results for certain performance indicators. The general room layout was voted to be 'very good', and the noise/vibration level in the room was regarded as 'quiet'. Most of them felt that the thermal comfort level of the room was 'slightly warm'. By contrast, the ventilation and IAQ of the room had been rated one rate lower than the overall results. The majority of the Indian respondents voted 'fair' for this performance indicator. Regarding the usage pattern of windows, 'safety' has become the main reason for the Indian respondents to not open the windows.

There are no obvious differences in the Malays' responses compared to the overall rate, except for responses on the ventilation control of the room. The majority of the Malay respondents voted 'fair' for this particular performance indicator.

4. Conclusions

The majority of the respondents are at a comfort level in all performance indicators of architectural elements, visual comfort, thermal comfort and indoor air quality. Therefore, the bioclimatic design strategies including daylighting and natural ventilation at an old residential building are still appropriate to meet the needs of contemporary life. However, there is still room for improvement, especially on the acoustic comfort.

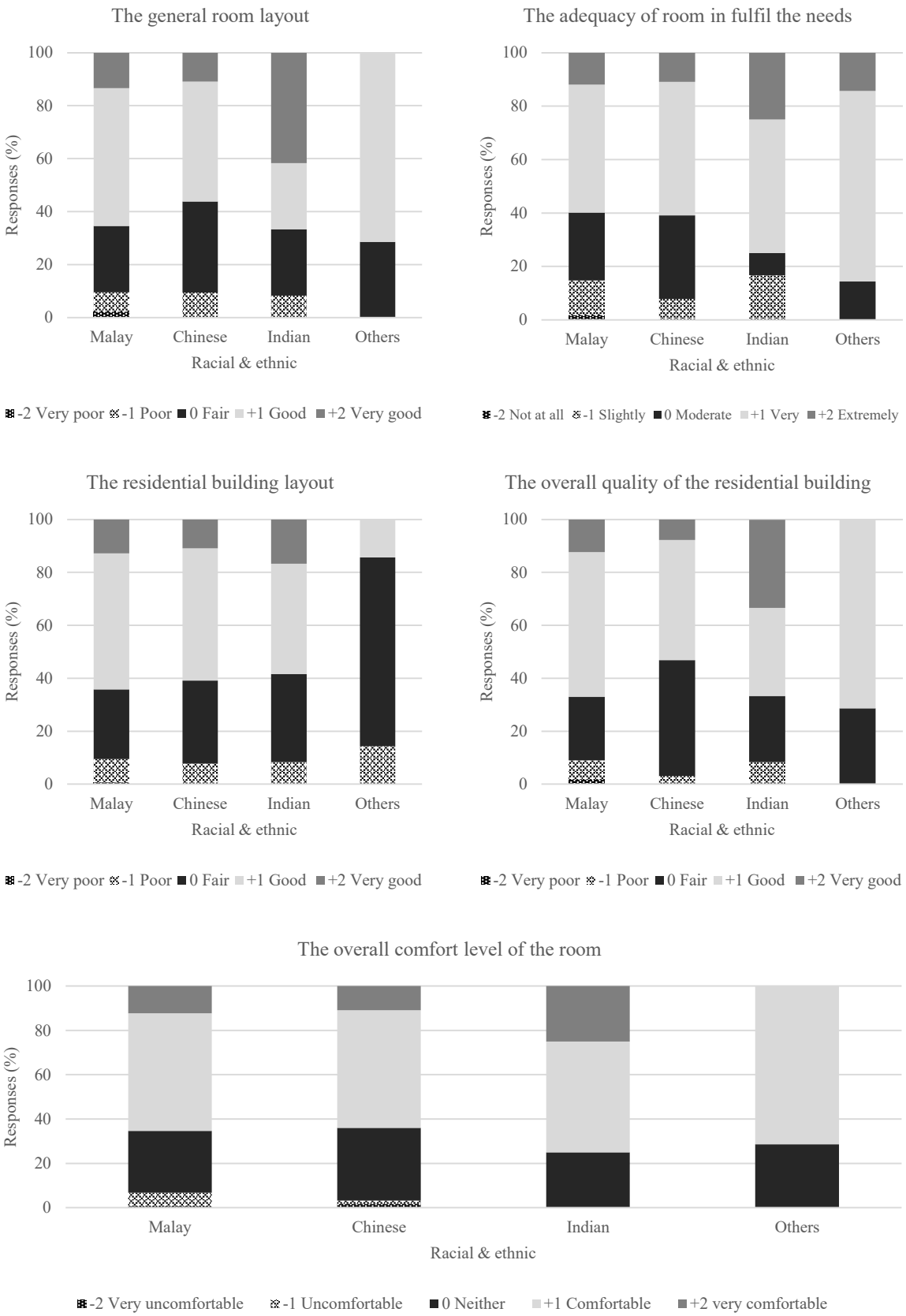

Figure 1: The result of satisfaction and perception survey on architectural elements according to the race and ethnicity

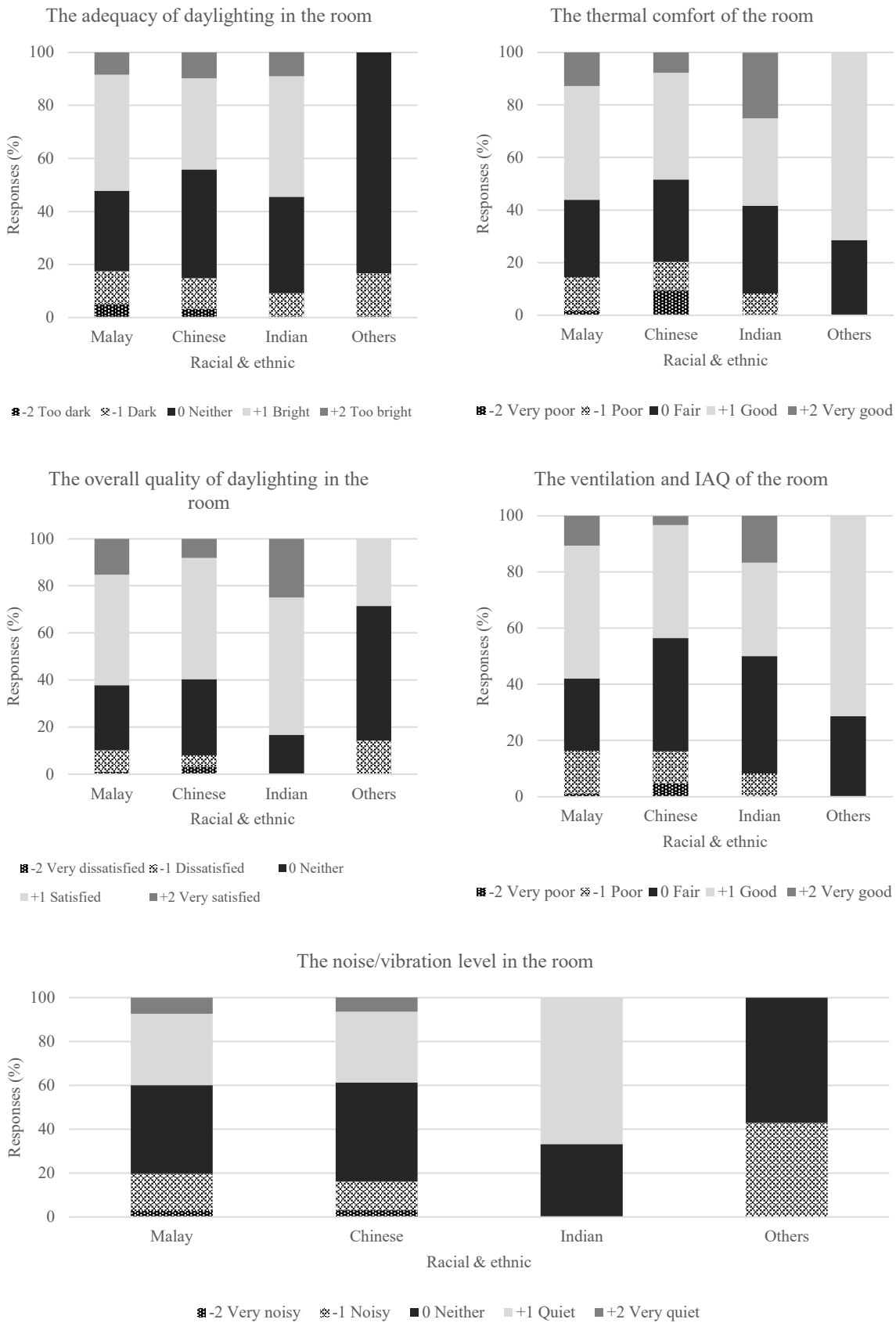

Figure 2: The result of satisfaction and perception survey on visual comfort, thermal comfort & IAQ and acoustic comfort according to the race and ethnicity

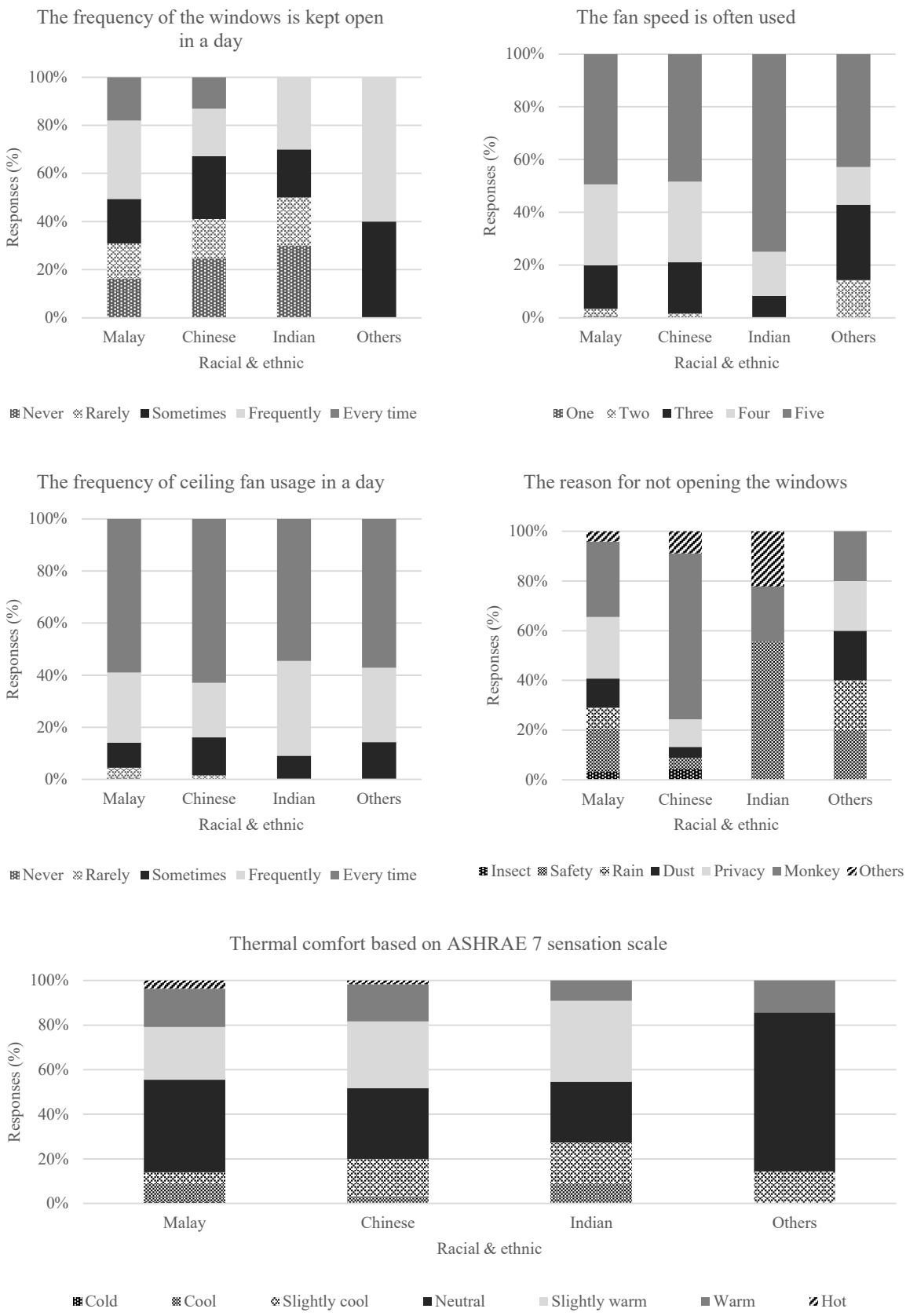

Figure 3: The usage pattern of windows, ceiling fan and the thermal comfort based on ASHRAE 7 sensation scale according to the racial and ethnic groups

The racial and ethnic composition considerably influence the satisfaction and the perception level of respondents. Therefore, these aspects should be highly considered in implementing the improvement measures to ensure the comfort level of the room. For further research, it is necessary to has greater number of respondents exceeding the minimum number of feedbacks with a 95% of confident level and ±5% margin of error to represent the overall population. The combination of subjective and objective evaluation would give a more comprehensive result for the investigated issues.

5. Acknowledgement

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