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Indoor Environmental Comfort in Student Hostel at Malaysia's Public University: A Literature Review

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ABSTRACT

This paper aimed to review existing literature on student hostel building facilities and its room's indoor environmental comfort condition in Malaysia's public university. This study is structured by brief analysis on relevant studies located globally and subsequently, focusing more on studies located in Malaysia. An overview of the subject matter is presented to provide insight. These are supported by reviews of published papers from the last 15 years (2005-2020) in relevancy to the subject area which includes important sub-areas. The literature search was conducted via academic search engines such as Google Scholar, Taylor and Francis Online, ResearchGate, Emerald Insight, Academia, SpringerLink, and ScienceDirect. Terms relevant to the subject area such as "Student Hostel", "Hostel", "Hostel Facilities", "Student Accommodation", "University Accommodation" and "University Facilities" are used for the literature search using the academic search engine. In achieving a more accurate search specific to a University's student accommodation (hostel building), a manual filtration was conducted to comb through the search results achieved from the academic search engines. The result of this literature review is a brief compilation of 18 global studies and focused on 29 studies in Malaysia, which are further classified/ grouped to form the structure of the paper. The review covers sub-areas such as building occupant's indoor environment health-related issues, comfort, and satisfaction. This review is significant and necessary as its input function as a continuous monitoring study for this field, enriching the current body of knowledge and may be a point of reference for future studies.

Keywords: University; hostel; indoor environment; health; comfort

INTRODUCTION

An educational building is an important building that functions to provide the future generation with knowledge. A university student spends an approximate minimum of four months per semester or eight months per year in a standard university's academic calendar running a two semester per year course.

For example, University Kebangsaan Malaysia (UKM) academic calendar runs two semesters per year; one semester consists of 14 weeks of lecture, one week for revision, and three weeks for examination (UKM 2020). That is equivalent to approximately 126 days per semester, a total of 252 days per year living in the university's compound, if not more.

In educational building, a classroom is an important space where teaching is conducted and student is learning. In this space, students' learning performance and productivity are practiced daily. However, the student hostel is also equally as important. A student hostel is a dormitory-style accommodation for the students to sleep and relax, after class revision, and casual interaction with fellow students. Its function is similar to the function of a bedroom at one's family house, although with a slight difference.

The university management must ensure that the accommodation provides sufficient comfort for the students' good night's sleep to power through the learning activities the next day. It is important to ensure students' comfort in the hostel room's indoor environment to nurture

a healthy sleep habit and optimum health in preparation for learning activities in the classrooms. The hostel room's indoor environmental condition remains ambiguous due to minimal continuous monitoring studies, particularly in the Malaysian context.

Wafi and Ismail (2008) highlight the reciprocal relationship between climatic conditions and humans in the building's indoor or outdoor environment. A tolerated indoor usually incorporates adequate climatic design consideration that is aligned with the outdoor environmental condition and serves the purpose to provide comfort.

This paper aims to review existing literature on the university's student hostel building facilities and its room indoor environmental condition, studies categorized by brief analysis on global studies and focusing more on the Malaysian context.

METHODOLOGY

The literature search was conducted via academic search engines such as Google Scholar, Taylor and Francis Online, ResearchGate, Emerald Insight, Academia, SpringerLink, and ScienceDirect as presented in Table 1. The literature search was conducted with terms relevant to the subject area such as "Student hostel", "Hostel", "Hostel facilities", "Student Accommodation", "University Accommodation", and "University Facilities". In achieving a more accurate search specific to a university student's accommodation (hostel building), a manual filtration is conducted to comb through the search results achieved from the academic search engines. The result of the literature search yielded results as shown in Table 1. The literature search was generated by academic search engines (i) Emerald Insight (three studies), (ii) ScienceDirect (one study), (iii) Taylor and Francis Online (one study), (iv) Google Scholar (nine studies), and (v) Research Gate (four studies).

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Table 2 literature search was generated by academic search engines (i) SpringerLink (one study), (ii) ScienceDirect (one study), (iii) Google Scholar (14 studies), (iv) Academia (four studies), and (v) ResearchGate (nine studies). Table 2 Publication on student hostel in

TABLE 1. Publication on student hostel located in Universities worldwide (2005 – 2020)

Title	Location	Author (Year)	Published for/ in	Search Engine	No of citations
Efficient retrofit actions and advanced control strategies for a student hostel	Italy	Ferrari (2005)	Proceedings of Passive and low energy cooling for the built environment (PALENC)	Google Scholar	2
Post-occupancy evaluation of postgraduate hostel facilities	Nigeria	Adewunmi et al. (2011)	Facilities; Emerald Group Publishing Limited	Emerald Insight	76
Post-occupancy evaluation of university student hostel facilities: A case study in Hong Kong	Hong Kong	Lai (2013b)	Proceedings Facilities Management and Maintenance	Google Scholar	3
Gap theory-based analysis of user expectation and satisfaction: The case of a hostel building	Hong Kong	Lai (2013a)	Elsevier; Building and Environment	ScienceDirect	14
A study on the performance of the student hostel facilities	Hong Kong	Lu (2013)	Hong Kong Polytechnic University	Google Scholar	-
Relative Importance of Student Accommodation Quality in Higher Education	Ghana	Nimako and Bondinuba (2013a)	Current Research Journal of Social Sciences	ResearchGate	37
An empirical evaluation of student accommodation quality in higher education	Ghana	Nimako and Bondinuba (2013b)	European Journal of Business and Social Sciences	ResearchGate	35
Student satisfaction with hostel facilities in Nigerian polytechnics	Nigeria	Toyin Sawyerr and Yusof (2013)	Journal of Facilities Management	Emerald Insight	60
Examination of the diversity of indoor molds in a Hungarian student hostel	Hungary	Varga (2013)	Journal of Acta Biologica Szegediensis	Google Scholar	4

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Students' satisfaction with hostel facilities in Federal University of Technology, Akure, Nigeria	Nigeria	Ajayi, Nwosu, and Ajani (2015)	European Scientific Journal	Google Scholar	34
Students' assessment of hostel facilities in the Polytechnic Ibadan, Ibadan, Nigeria: realities and challenges	Nigeria	Akinpelu (2015)	Research on Humanities and Social Sciences	Google Scholar	10
A qualitative study investigating the impact of hostel life	Pakistan	Iftikhar and Ajmal (2015)	International Journal of Emergency Mental Health and Human Resilience	Google Scholar	33
Impact of hostel students' satisfaction on their academic performance in Sri Lankan universities	Sri Lanka	Mansoor and Hussain Ali (2015)	5th International Symposium	Google Scholar	9
Post Occupancy Evaluation of Postgraduate students' hostel facilities and services	Ghana	Agyekum, Ayarkwa, and Amoah (2016)	Journal of Building Performance	ResearchGate	17
Quality assessment of student housing facilities through post-occupancy evaluation	Saudi Arabia	Sanni-Anibire and Hassanain (2016)	Architectural Engineering and Design Management	Taylor and Francis Online	41
Students' satisfaction with hostel accommodations in higher education institutions	South Africa	Oke Ayodeji, Aigbavboa Clinton, and Raphiri Marcia (2017)	Journal of Engineering, Design, and Technology	Emerald Insight	17
Analysis of students' satisfaction with hostel facilities: A case study	Pakistan	Memon, Solangi, and Abro (2018)	Sindh University Research Journal - SURJ (Science Series)	ResearchGate	8
Post-occupancy evaluation of student's hostel facilities in Federal Universities in North Central, Nigeria	Nigeria	Philip, Ileanwa, and El-Hussain (2018)	Architecture Research	Google Scholar	8

TABLE 2. Publication on student hostel in Malaysian University (2009 – 2020)

Title	Author (Year)	Published for/ in	Search Engine	No of citations
Evidence base prioritization of indoor comfort perceptions in Malaysian typical multi-storey hostels	Dahlan et al. (2009a)	Elsevier; Building and Environment	ScienceDirect	56
Daylight Ratio, Luminance, and Visual Comfort Assessments in Typical Malaysian Hostels	Dahlan et al. (2009b)	SAGE Journals; Indoor and Built Environment	Google Scholar	47
Development of sustainable campus: Universiti Kebangsaan Malaysia planning and strategy	Darus et al. (2009)	WSEAS transactions on Environment and Development	Google Scholar	31
Managing Sustainability in Universiti Kebangsaan Malaysia	Mat et al. (2009)	Environmental Problems and Development	Google Scholar	9
Graduates' Perceptions towards UKM's Infrastructure	Omar et al. (2009)	College Student Journal	Google Scholar	3
The factors predicting students' satisfaction with university hostels, case study, Universiti Sains Malaysia	Khozaei et al. (2010)	Canadian Center of Science and Education; Asian Culture and History	ResearchGate	96
Satisfaction with hostel among different ethics in Malaysia, Case study Universiti Sains Malaysia hostels	Khozaei, Hassan, and Khozaei (2010)	National Postgraduate Seminar	Academia	-

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The University Development Planning from The Aspects of Accessibility and Circulation: A Comparative Study of Four Malaysian Universities	Mohd-Nor MFI et al. (2010)	Energy, Environment, Sustainable Development, and Landscaping	ResearchGate	-
Measuring satisfaction with student housing facilities	Nurul Ulyani, Nor Aini, and Zulkifli (2010)	American Journal of Engineering and Applied Sciences	Academia	83
Environmental study satisfaction: Case of public universities in Klang Valley-student's hostel room prepared	Rahaman, Adilla, and Mustapha (2010)	Institutional Repository	Google Scholar	-
Student residential satisfaction in research universities	'Ulyani Mohd Najib, Aini Yusof, and Zainul Abidin (2011)	Journal of Facilities Management	Academia	94
Toward a sustainable campus: comparison of the physical development planning of research university campuses in Malaysia	Abd Razak et al. (2011)	Journal of Sustainable Development	ResearchGate	43
Stress and Academic Achievement among Undergraduate Students in Universiti Putra Malaysia	Elias, Ping, and Abdullah (2011)	Procedia-Social and Behavioral Sciences	ResearchGate	274
Thriving in a faculty and a college setting	Shahabudin, Razak, and Khoon (2011)	College Student Journal	Google Scholar	1
A case study of the climate factor on thermal comfort for hostel occupants in Universiti Sains Malaysia (USM), Penang, Malaysia	Wafi, Ismail, and Ahmed (2011)	Journal of Sustainable Development	ResearchGate	19
Students' perception on the service quality of Malaysian universities' hostel accommodation	Bashir, Sarki, and Samidi (2012)	Journal of Business and Social Science	ResearchGate	30
Student satisfaction on facilities provided at Universiti Malaysia Kelantan Hostel (Campus Kota)	Muhamed (2013)	Institutional Repository	Google Scholar	-
Student expectation and perception of service quality	Kasim (2014)		Google Scholar	-
Student Perception on Student Housing Facilities in Universiti Teknologi Malaysia through Post Occupancy Evaluation	Yen (2014)	Institutional Repository	Google Scholar	2
Students' Attitude and Satisfaction Living in Sustainable On-Campus Hostel	Mohd Suki and Chowdhury (2015)	Malaysian Journal of Business and Economics	Google Scholar	23
Assessing students' perceptions to sustainability practices at National University of Malaysia (UKM)	Kwami et al. (2015)	International Journal of Environment and Sustainable Development	Google Scholar	3
Hostel Facility Maintenance Preliminary Finding of Higher Education Institution in Malaysia	Tunggal (2015)	International Journal of Scientific and Research	ResearchGate	-
Student attrition at technical and vocational educational training (TVET) institutions: the case of XCel Technical College in Malaysia	Had Sabtu, Wan Mohd Noor, and Mohd Isa (2016)	Institutional Repository	Google Scholar	3

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Factors which influence student satisfaction among international postgraduate students in Universiti Utara Malaysia	Khaled Mohamed Helmy (2016)	Institutional Repository	Google Scholar	-
Student Satisfaction with Hostel in International Campus: A Literature Review	Hasanah et al. (2017)	Proceedings of the 14th ·250· International Conference on Innovation and Management	ResearchGate	-
Energy Consumption in Student Hostels of Universiti Sains Malaysia: Energy Audit and Energy Efficiency Awareness	Ng et al. (2017)	Handbook of Theory and Practice of Sustainable Development in Higher Education	SpringerLink	3
Student's level of satisfaction in residential college facilities at Universiti Teknologi Malaysia	Muhammad Nizam, Mohamamad Fadhli, and Nur Hidayah (2018)	Institutional Repository	Academia	-
Student Satisfaction On Hostel Facilities in Politeknik Kuching Sarawak	Yoong Chow, and Tze Ching (2019)	Online Journal for TVET Practitioners	Google Scholar	1
Relative satisfaction index on students' satisfaction towards hostel facilities	Mansor et al. (2020)	TEST Engineering and Management/ The Mattingley Publishing Co., Inc.	ResearchGate	-

Malaysian university yielded results starting from the year 2009 – 2020. There is no relevant publication identified and unavailable on an academic search engine before 2009 on university student hostel in Malaysia.

The papers are further examined and classified into subcategories (i) Indoor environmental parameters and non-Indoor environmental, (ii) Post-occupancy evaluation or satisfaction. For subcategory Indoor Environmental parameters, the author specifically chose Malaysia's Green Building Index Indoor Environmental Quality (EQ) five parameters; (EQ1 Indoor Air Quality, EQ2 Thermal Comfort, EQ3 Lighting, EQ4 Visual, and EQ5 Acoustic) as a mean of standardization, as the paper also touches on brief reviews on sustainability and green movement in Malaysia's public higher education industry.

Additional publications outside of these are included to build the premise of this review. It includes a review of Malaysia's public higher education system; progressive historical timeline, policy, budget allocation in relevance to facilities, movement towards sustainability, and any other relevant sub-areas.

INDOOR EQ PARAMETERS AND NON-EQ PARAMETERS

Based on the analysis in Table 3, in the 15 years, there are only 18 identified relevant literature that is on student hostel globally (except for Malaysia) and only five of those literature focused on variants from Indoor Environmental

TABLE 3. Subcategory IEQ and Non-IEQ parameters; Publication on student hostel in global University

Author (Year)	Location	EQ parameters	Non-EQ parameters or sub-component of EQ parameter
Ferrari (2005)	Italy	Incorporated 4/5 GBI EQ parameters as a variable except for EQ3.	Energy and environmental performance
Adewunmi et al. (2011)	Nigeria	Non	Facilities maintenance and management (29 performance criteria)
Lai (2013b)	Hong Kong	Incorporated 4/5 GBI EQ parameters as a variable except for EQ1, EQ4.	Facilities; air-conditioning, fire safety, internet, and hygiene.
Lai (2013a)	Hong Kong	Incorporated 4/5 GBI EQ parameters as a variable except for EQ1, EQ3.	Facilities; fire safety, hygiene, and communication via information technology
Lu (2013)	Hong Kong	Non	Management factor; security regulation, application for hostel accommodation, withdrawal process, and fees refund, entrance regulations, hostel regulations, students services.

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Nimako and Bondinuba (2013a)	Ghana	Non	Facility; physical environment, utility quality, overall impression, security, toilet, distance to lecture, accommodation fee, access to transport, entertainment facility.
Nimako and Bondinuba (2013b)	Ghana	Non	Facility; physical environment, utility quality, overall impression, security, toilet, distance to lecture, accommodation fee, access to transport, entertainment facility.
Toyin Sawyerr and Yusof (2013)	Nigeria	Non	Facilities
Varga (2013)	Hungary	Incorporated 2/5 GBI EQ parameters as a variable except for EQ3,EQ4, EQ5.	Mold
Ajayi, Nwosu, and Ajani (2015)	Nigeria	Non	Facilities; Bathroom, toilet, laundry, distance from rooms, and hygiene.
Akinpelu (2015)	Nigeria	Non	Facilities; Physical Maintenance, and Management
Iftikhar and Ajmal (2015)	Pakistan	Non	Social and cultural aspects
Mansoor and Hussain Ali (2015)	Sri Lanka	Non	
Agyekum, Ayarkwa, and Amoah (2016)	Ghana	Non	Facilities and services
Sanni-Anibire and Hassanain (2016)	Saudi Arabia	Incorporated all 5/5 GBI EQ parameters.	Quality of building support services, performance, and control of thermostats, furniture, size of rooms, and proximity to the cafeteria. Indoor Environmental Quality, design quality, and building support services.
Oke Ayodeji, Aigbavboa Clinton, and Raphiri Marcia (2017)	South Africa	Non	Ethnicity, Facilities; Neighbourhood, environmental, Unit features, building quality and services, rules, the effectiveness of the lift system, the size of wardrobe and closet, laundry service, numbers of electrical sockets, and window quality.
Memon, Solangi, and Abro (2018)	Pakistan	Non	Services; Food Quality, Water supply, Hygiene, First Aid.
Philip, Ileanwa, and El-Hussain (2018)	Nigeria	Non	Facilities; Overcrowding, no recreational spaces, and minimal internet services.

**Note: Malaysian Green Building Index Indoor Environmental Quality (EQ) 5 parameters;*
EQ1 Indoor Air Quality
EQ2 Thermal Comfort
EQ3 Lighting
EQ4 Visual
EQ5 Acoustic

Quality five parameters. Four studies incorporated four out of five EQ parameters while one study incorporated the five EQ parameters.

Based on the analysis in Table 4, in the 12 years, there were only 29 identified relevant literature that is on student hostels in Malaysia, and only five of that literature focused on variants from Indoor Environmental Quality five parameters. None of these used all five parameters. These strengthen the need to fill the identified gap that is lacking in the body of knowledge for the recent 10-year period.

MALAYSIAN PUBLIC HIGHER EDUCATION INDUSTRY

Malaysia education is governed by the Laws of Malaysia Act 550; Education Act 1996, established overseeing the education and any associated relevant operation. The National Education System encompasses five education levels; pre-school, primary, secondary, post-secondary, and higher education (Malaysian Government 2016).

The higher educational institution is highly responsible

TABLE 4. Subcategory IEQ and Non-IEQ parameters; Publication on student hostel in Malaysian University

No	Author/ Year	IEQ parameters	Non-IEQ parameters or sub-component of EQ parameter
1	Dahlan et al. (2009a)	Incorporated 4/5 GBI EQ parameters as a variable except for EQ1 Indoor Air Quality (IAQ).	Temperature, Daylight ratio, Luminance
2	Dahlan et al. (2009b)	Incorporated 2/5 GBI EQ parameters as a variable except for EQ1 Indoor Air Quality (IAQ), EQ2 Thermal Comfort, and EQ5 Acoustic.	Daylight, Luminance
3	Darus et al. (2009)	Non	Sustainability
4	Mat et al. (2009)	Non	Sustainability
5	Omar et al. (2009)	Non	14 other components
6	Khozaei et al. (2010)	Non	Fees, hostel security, room safety, distance from university facilities, room size, and hostel facilities.
7	Khozaei, Hassan, and Khozaei (2010).	Non	Hostel rules and regulations, hostel distance from facilities, hostel distance from school, design and layout, hostel population, fees, sharing the room, and many more.
8	Mohd-Nor MFI et al. (2010)	Non	Campus physical planning.
9	Nurul Ulyani, Nor Aini, and Zulkifli (2010)	Non	Hostel facilities.
10	Rahaman, Adilla, and Mustapha (2010)	Incorporated 4/5 GBI EQ parameters as a variable except for EQ4 Visual.	Ventilation, ergonomics.
11	'Ulyani Mohd Najib, Aini Yusof, and Zainul Abidin (2011)	Non	Hostel facilities.
12	Abd Razak et al. (2011)	Non	Campus physical planning.
13	Elias, Ping, and Abdullah (2011)	Non	Stress level.
14	Shahabudin, Razak, and Khoon (2011)	Non	University infrastructure
15	Wafi, Ismail, and Ahmed (2011)	Incorporated 2/5 GBI EQ parameters as a variable except for EQ3 Lighting, EQ4 Visual and EQ5 Acoustic.	Relative humidity, Temperature, Globe temperature, Air Velocity.
16	Bashir, Sarki, and Samidi (2012)	Non	Hostel service quality.
17	Muhamed (2013)	Non	Hostel facilities.
18	Kasim (2014)	Non	Hostel service quality.
19	Yen (2014)	Non	Hostel facilities (12 performance criteria); functionality (technology), security (security system), and many more.
20	Mohd Suki and Chowdhury (2015)	Non	Location, facilities, quality
21	Kwami et al. (2015)	Non	Sustainability, natural resources (water, energy, waste, etc).
22	Tunggal (2015)	Non	Maintenance management system.
23	Had Sabtu, Wan Mohd Noor, and Mohd Isa (2016)	Non	Student attrition/ withdrawal.
24	Khaled Mohamed Helmy (2016)	Non	Accommodation, transportation, cafeteria food service, and teaching quality.

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25	Hasanah et al. (2017)	Non	Expectancy Disconfirmation Theory, student housing satisfaction, customer satisfaction, and link between uncertainty avoidance and customer satisfaction.
26	Ng et al. (2017)	Incorporated 1/5 GBI EQ parameters: EQ3 Lighting.	Energy audit activities.
27	Muhammad Nizam, Mohamamad Fadhli, and Nur Hidayah (2018)	Non	Hostel facilities and rental rates.
28	Jemien, Yoong Chow, and Tze Ching (2019)	Non	Hostel facilities.
29	Mansor et al. (2020)	Non	Hostel facilities.

to carry out a distinctive role in human development and human capital. Academicians, whose knowledge and insights are pursued diligently belonged to the country's affluent and valued community. Universities are also an establishment where the student spends a part of their adolescent years for social and intellectual development. Ideally, the students will be prepped and able to contribute towards the nation-building future-forward.

Malaysia's 20 public universities saw a total of 567 625 student enrolment in 2019. Most student enrolment is from Universiti Teknologi MARA (UiTM) with 181 501 and the least is from Universiti Pertahanan Nasional Malaysia (UPNM) with 4 983. Universiti Kebangsaan Malaysia had 33 983 student enrolment, Universiti Teknologi Malaysia had 33 632 student enrolment, Universiti Malaya had 32 915 student enrolment, Universiti Utara Malaysia had 31 804 student enrolment, Universiti Sains Malaysia had 30 395 student enrolment, Universiti Islam Antarabangsa Malaysia had 29 369 student enrolment and Universiti Putra Malaysia had 28 696 student enrolment.

PUBLIC UNIVERSITY'S STUDENT HOSTEL FACILITIES

Education Act 1996; Part 4 of the National Education System; Chapter 12 Provision of Facilities and Services stated the "Boarding facilities" clause which specifies the role of the responsible minister to assist on accommodation facilities and is specified as;

> "Without prejudice to the generality of the power conferred by section 64, the Minister may, where pupils cannot reasonably be provided with the requisite education or training unless boarding accommodation is provided, make such arrangements for the accommodation (whether free or subject to such charges as the arrangements provide) as he may consider appropriate" (Malaysian Government 2016).

The student hostel functioned to meet the student's accommodation need. In fulfilling the competitive demand, student hostels are very crucial in providing students with accommodation in support of a better learning opportunity. Indirectly, it attracts and retains student attrition in the university enrollment numbers. To improve the university's performance, student hostels, therefore, need to be equipped with effective facilities and good services (Yen 2014).

The steady growth of higher education institution enrolment numbers has prompted the government to improve the competitiveness of universities in all aspects. The increase in student enrollment has led to the demands for enhancement of student accommodation, teaching and learning facilities as well as other facilities. Necessary facilities are in place in each university to accommodate the needs of the student population (Shahabudin, Razak and Khoon 2011).

The need to accommodate such student enrolment numbers had prompt the establishment of multi-storey student hostels by the university, both on and off-campus (Dahlan et al. 2009a). These multi-storey student hostels mostly range from a three to six-story height, although there are occasional student hostel blocks that are higher than this.

Each student's residential college/ hostel accommodates a variety of student numbers to fit the space capacity and the university management decision on the apartment/ room space layout. Some university offers room for one or a one-bedroom apartment/ studio. Some offers shared room that can accommodate two to four person. Some, have the luxury to offer a whole unit apartment for students cohabitating with their family. Any available option is depending on the student's financial capabilities.

STUDENT HOSTEL'S INDOOR ENVIRONMENTAL IMPACT ON STUDENTS' HEALTH, COMFORT AND SATISFACTION

Indoor Environmental parameters (Indoor Air Quality, Thermal comfort, Lighting, Visual, Acoustic) significantly influence Malaysian students' comfort and satisfaction in the hostel. Indoor environmental health issues may develop if precautions are not made that could affect student's comfort and satisfaction.

EQ PARAMETER 1: INDOOR AIR QUALITY (IAQ)

Building requires continuous assessment especially throughout its operational stage as its full potential becomes more evident to demonstrate the life cycle of a building (Abdulaali, Usman, and Al-Ruwashedi 2019). Any types of building are responsible to provide a healthy indoor environment for their occupants, therefore maintaining and evaluating Indoor Environmental Quality (IEQ) parameters is critical throughout a building's lifecycle (Abdulaali et al. 2020) Laquatra et al. (2008) defined Indoor Air as "air in building spaces occupied by inhabitants with varying health conditions for at least one hour". Asadi, Da Silva and Costa (2010) highlighted that existing studies on Indoor Air Quality (IAQ) are based on its significance to human comfort, satisfaction, health, productivity, and performance. Roelofsen (2002) explained that building occupants experienced differing air quality based on individual thermal experience, hence, air quality affects building occupant's productivity differently from one another.

Indoor Air Pollutants (PAI) - Indoor air has a bigger impact on human health and life in general. Naturally, indoor air does have a certain number of contaminants in its properties. Ineffective air filtration, poor ventilation, and poor maintenance contribute to the air contaminants lingering in the air. Its prolonged concentration in the indoor air is what affects the indoor air comfort as it impacted the health of its building occupants.

The indoor air pollutants (PAI) may comprise biological or chemical contaminants. Guida, Pagliuca and Rospi (2008) listed down the notable predominant chemical substances in nature as formaldehyde, carbon monoxide, carbon dioxide, radon, sulphur dioxide, and volatile organic compounds. Hongxiang and Hongli (2004) listed biological contaminants that comprises dust mites, molds, pests, houseplants, endotoxins, pollen.

TABLE 5. List of indoor air contaminants and the acceptable limits

Indoor Air Contaminants	Acceptable limits		
	ppm	mg/m3	cfu/m3
Chemical contaminants		-	-
• Carbon monoxide	10	-	-
• Formaldehyde	0.1	-	-
• Ozone	0.05	-	-
• Respirable particulates	-	0.15	-
• Total volatile organic compounds (TVOC)	3		
Biological contaminants			
• Total bacterial counts			500*
• Total fungal counts	-	-	1000*
Ventilation performance indicator			
• Carbon dioxide	C1000	-	-

Notes:

For chemical contaminants, the limits are eight-hour time-weighted average airborne concentrations.
mg/m3 is milligrams per cubic meter of air at 25° C and one-atmosphere pressure.
ppm is parts of vapor or gas per million parts of contaminated air by volume.
cfu/m3 is colony-forming units per cubic meter.
C is the ceiling limit that shall not be exceeded at any time. Readings above 1000ppm are an indication of inadequate ventilation.
**excess of bacterial counts does not necessarily imply health risk but serves as an indicator for further investigation.*

Source: Department of Occupational Safety and Health Malaysia (2019)

Table 5 shows the acceptable limits of contaminants in indoor air based on Department of Occupational Safety and Health Malaysia (2019).

If indoor air contaminants are kept at a controlled minimum level, it is still acceptable for human dwelling. However, if the amount exceeds its acceptable level, this indoor air contaminant may contribute to deteriorating

health over time. To maintain the indoor air contaminants concentration value, it is necessary to have air replacement via air ventilation through building space in ensuring the air quality comfort is achieved. Strategic method to ensure Indoor Air Quality (IAQ) includes analyzing the impact of indoor air contaminant levels and the ventilation system, in addition to managing the responses from building occupants (Zyla-Wisendale and Stolwijk 1990).

Indoor Air Health-related Issues - Indoor environment role is significant for human health and well-being. There is always an ongoing concern in recent studies on the hazardous effect of growing indoor mold or fungi, a biological pollutant. Its growth is widely distributed indoor and outdoor. Fungi growth is distributed pervasively in the indoor environment and poses a threat to public health (Samson et al. 2010).

Molds or microscopic fungi can grow on any material with the presence of temperature and humidity (moisture and oxygen) (Scott 2001). Mold or fungi growth thrive in humid conditions and high-temperature. Visible mold, mold odors, and indoor contaminants combination may culture conditions for allergen and irritants (Tavernier et al. 2006). It spreads generally in heating/ cooling appliances (e.g., ventilation and air conditioning systems), building materials, and furnishings/ finishes (ceiling tiles, carpets, wallpapers, insulations) (Samet and Spengler 2003).

In relevance to mold or fungi growth in student hostels, Varga (2013) studied fungi growth and distribution in a Hungarian student hostel in 2009 and found significant differences at different locations. Different hostel spaces have different types of mold or microscopic fungi growth, with varying growth concentrations in sizes (Sudhadham et al. 2008).

There are health hazards posed by indoor environment pollution caused by fungi species which includes infection, allergies (Jarvis and Miller 2005; Khan and Karuppayil 2012), and toxicity. Its mycotoxin-producing abilities and human pathogens are also hazardous to building occupants (Samson et al. 2010). Matos et al. (2002) found that in East Asia, some fungi species cause fatal brain infections and chromoblastomycosis.

Indoor bacteria or fungi can cause infectious, allergic, toxic, or inflammatory diseases called building-related illnesses (Piecková 2003) or sick building syndrome. E.P.A. (2020) listed "Sick Building Syndrome" (SBS) health symptoms as eyes, nose and throat irritation, infection of the upper respiratory, fatigue, dizziness, headaches, nausea, or sleepiness. Sick Building Syndrome (SBS), and various respiratory allergies are caused by indoor air's excessive amount of nitrogen oxides (NOx), carbon dioxide (CO2) and respirable suspended particulates (RSPs) in building spaces.

Shaughnessy et al. (2006) listed the impact of poor Indoor Air Quality (IAQ) condition as short term and long-term health issues; asthma or respiratory illness, absenteeism, student occupants' productivity deteriorates, employee and student distress relationship, liability issue and deteriorate, and reduce cooling equipment's efficiency.

Hence, a proper indoor environmental design for student hostel buildings and the room is necessary to mitigate the growth of mold, penetration of air pollutants, and the efficiency of the air filtration system and ventilation.

EQ PARAMETER 2: THERMAL COMFORT

Various study on methods of thermal comfort evaluation has been conducted throughout the years in the pursuit to assess any given spaces in a building. Due to ongoing study on thermal comfort improvement, there is a relevant thermal comfort design requirement that has triggered the improvements of building design and personal control system (De Dear and Brager 2002; ASHRAE Standard 55 2017). There are thermal variables for comfort and physical measurements as outlined by ASHRAE Standard 55 (2017).

De Dear and Brager (1998) explained thermal comfort as:

"metabolism levels that can be assessed by variables that include activities, clothing resistance, air temperature, relative humidity, air velocity, and mean radiant temperature".

Guida, Pagliuca and Rospi (2008) explained Thermo-hygrometric comfort is influenced by varied factors namely:

1. environment (temperature, relative humidity, wind velocity, solar radiation, and atmospheric pressure),
2. associated with physical activity (metabolic energy),
3. associated with worn garments (thermal clothing Icl) and
4. percentage of metabolic energy utilized during physical activity (mechanical performance – value).

ASHRAE Standard 55 (2017) specified thermal condition as: "thermal condition is the condition of mind which expresses satisfaction with its thermal environment and will be influenced by radiant temperature, air temperature, air velocity, and relative humidity".

Seppanen and Fisk (2006) study found that building occupants' productivity in indoor spaces will decline if the indoor temperature increases above 25°C. Herrington (1952): Patnaik and Mishra (2014) study states that building occupants usually experience negative psychological consequences when the indoor temperature

exceeds 26.67°C, further impacting their work performance and productivity.

With student hostels located in tropical climate zones, the climate affects the level of building occupants' thermal comfort (Wafi, Ismail and Ahmed 2011). Factors affecting the indoor environment thermal comfort performance are listed as air temperature, globe temperature, radiant temperature, relative humidity and air velocity.

Additionally, Humphreys and Nicol (2002) grouped two physiological metabolism variables as result of activities and the thermal resistance of clothing, and climate variables that include air temperature, air velocity, relative humidity, and radiant temperature.

De Dear and Brager (2002), Ruck (1989) and Wong et al. (2002) described physical-physiological variables that may define expectations on thermal comfort as body proportions, the female menstruation cycle, age, sex, food, international air movements, and irregular indoor thermal comfort expectation.

In a public university, there are rules and regulation put in place that restricts the student occupant's level of freedom. Hence, in relevance to this study on student hostel buildings and rooms, there are some notable study throughout the years highlighted in upcoming findings.

Dahlan et al. (2008) suggested that one ceiling fan can accommodate a room volume not more than 50 m3. Sufficient air velocity is necessary for air ventilation in a space. Air velocity in student hostel rooms can mitigate various discomfort that led to student occupants' health issues. Cheng, Hwang and Lin (2008) study states the acceptable temperature range with the fan turned on are 28.2ºc and 27.2ºc for direct and indirect analysis. Strong circulations forced by the fan induce convective heat transfer, which resulted in a uniform temperature distribution throughout the room (Ho, Rosario and Rahman 2009).

Another study by Dahlan et al. (2009a) found that student occupants at multi-storey hostels in Malaysia were most concerned with their hostel rooms' thermal condition. However, the student occupants tolerated the existing condition of their hostel rooms' indoor climate which indicated that there is no need to implement climate-controlled strategies.

Wafi, Ismail and Ahmed (2011) studied the climatic factor impact on the indoor thermal comfort of student occupants in Universiti Sains Malaysia (USM) hostel. Malaysian student occupants willingly adapt to varying hostel room's indoor environment by self-initiative such as a change of clothes, opening the door, and utilizing the fan to improve air temperature.

A study by Lai (2013b) determined that student occupants desired air-conditioning as the most expected parameter to have in the student hostel room. Although, air-conditioning ranked lowest in the level of satisfaction from the overall aspect.

From the above studies, it may be concluded that student occupants are flexible and tolerant in adjusting to the existing indoor thermal condition. Other than the discomfort experienced by student occupants, other impacts may occur. Firstly, the indoor temperature is closely linked to Sick Building Syndrome (SBS) whereby its pervasiveness is driven by high temperatures. Indoor temperatures may also cultivate the growth of mold or fungi, in combination with the appropriate amount of moisture and air (Nielsen 2003).

EQ PARAMETER 3: LIGHTING

Lighting is a significant indoor environment component in any building. Architects and interior designers are responsible to decide suitable lighting types and layouts with appropriate dimensions to attain an optimal lighting environment. The dimensions that should be taken into consideration includes the lighting level (illumination and lamination), light transmission, and consistency, and glare control (Hwang and Kim 2011).

Conventional building designs in Malaysia are shifting towards improvements in response to their environmental condition via the manipulation of daylighting to improve indoor lighting levels and building occupants' visual comfort. However, architects need to be wary of daylighting strategies flaws that may lead to disadvantages that may cause visual discomfort, hinder vision, increasing energy demands excessively, and increase interior heat gain (Dahlan et al. 2009).

TABLE 6. Lighting level (lux) based on work activities

Lux levels requirement	Work activities
200 lux	Work activities that require infrequent reading and writing
300 lux to 400 lux	General office work activities; frequent reading and writing
300 lux to 400 lux	Drawing offices

Department of Standards Malaysia (2007) specified lighting level (lux) for comfort requirements based on different work activities as listed below:

In relevance to this study, a study by Lai (2013b) on Post-Occupancy evaluation on student hostel in Hong Kong determined that lighting is the third-highest mean level of expectation which means that the student occupants desired

this aspect as the third most expected as compared to the remaining five aspects. However, as compared to the other five remaining aspects, the student occupants are the most satisfied with the lighting aspect in their hostel room.

Student hostel rooms must be equipped with the appropriate lighting dimensions as discussed earlier. Receiving optimal daylighting quality, in combination with the appropriate artificial lighting dimensions in any building space is essential. Boyce (2014) states that a room with a lack of daylight may affect the building occupant's concentration in performing tasks or reduce their work performance.

Lighting substantially affects the psychological and physical health of building occupants as any visual discomfort triggered by excessive lighting may cause fatigue (Hwang and Kim 2011), dizziness, headache, and migraine for highly sensitive people. Boyce (2014) listed the health-related issue triggered by insufficient or excessive lighting levels such as dry eyes, eye irritation, allergic reaction, and headaches.

This condition is explained by Walls, Walls and Benke (2011) stating that fluorescent light emits UV light in a considerable amount which may cause varying eye-related health issues to a highly sensitive person such as a UV light related eye disease. This further affects building occupant's health, comfort, and satisfaction which leads to impact their performance and productivity.

On the positive side, an optimal lighting condition may improve building occupant's vision comfort, enhances attitude and emotion, and improves focus (Musa et al. 2012). Ambient lighting conditions may relieve seasonal anxiety and depression (Boyce 2014). It may also improve energy conservation and building occupants' morale, work quality, and productivity (Leung and Fung 2005).

EQ PARAMETER 4: VISUAL

Zain-Ahmed et al. (2002) classified the Malaysian sky as an intermediate sky with characteristics of having 6-7 oktas cloud cover value that makes up an average cloudy condition. The possibility for daylighting implementation in Malaysia is high due to:

1. Daylighting design is in the range of 10-80 klx for the period between 8 am to 5 pm.

2. External illumination total percentage (%) is above 10 klx during work hours is 93%.

A combination of natural and artificial lighting fixtures enhances lighting quality in the building's indoor spaces by creating a high-performance luminous ambience. Malaysia's high sky irradiance factor contributes to visual discomfort (Dahlan et al. 2009b). Glare, caused by the sky and sunlight poses a significant visual impact to affected building occupants.

Pritchard, D. C. (1999) characterized visual comfort as:

> "requires satisfactory illuminance of the task that is being undertaken and agreeable general appearance of the interior".

Dahlan et al. (2009a) studied the effect of indoor climate in typical multi-storey hostels in Malaysia and found that student occupants rated visual condition as the third most concern for its indoor environment parameter. The student occupants are comfortable and satisfied with the daylighting level that penetrates the rooms through a side-lit window although there is a slight difference in daylighting level between rooms that are shaded by projecting balconies above level and rooms that are not.

It was also noted that student occupants' visual comfort is significantly influenced by the day's climate condition regardless of room and window size or having shade from projecting balcony from the level above. Student occupants could rate their visual comfort depending on the amount of light penetrating through the window. This is because the mean luminance levels observed on Overcast and Clear Days differed significantly.

EQ PARAMETER 5: ACOUSTIC

An efficient acoustical condition can filter or block external noise from penetrating the indoor environment. Noise sources may come from the interior or exterior context and the level of indoor noise is influenced by the noise source distances. Acoustical Society of America (A.S.A) (2019) states the maximum reverberation is from 0.6 to 0.7 seconds and the maximum background noise should be 35 decibels in an unoccupied space.

In addition, "noise and reverberation have lowered the speech intelligibility rating to 75 percent, meaning that the average listener picks up only 75 percent of what is said". The appropriate background noise of acceptable limit of no more than 35 decibels like music enriches the space's sensory experience, assist in enhancing the alertness and stimulate relaxation (Knirk 1992; Leung and Fung 2005).

Earlier research on acoustic proves that noise exposure is capable to impact building occupant's productivity (Cash 1993; Hines 1996; Earthman 2004; Uline and Tschannen-Moran 2008; Warren Lanham 2019). Long-term exposure with noise levels outside of the comfort zone may imply hearing as it can cause hearing problems or permanent damage.

Harris (1991) stated that building occupants are disturbed by noise levels that are higher than the comfort

level and prolonged negative acoustical condition impacted their hearing ability. Noise pollution can also affect the building occupants' psychological well-being by diminishing personal motivation and efficiency while performing a task, and productivity (Evans and Stecker 2004). Leung and Fung (2005) emphasized that excessive noise negative impact can affect one's psychosocial relationships, work performance and can cause health problems such as elevated blood pressure and hearing loss.

Haghighi and Jusan (2012) support preceding studies that poor acoustical conditions in indoor spaces negatively affect building occupant's communication and interaction, which further affect their work performance. W. Evans and Maxwell (1997), Maxwell and W. Evans (2000), Haines et al. (2001), and Uline and Tschannen-Moran (2008) supported the statement that "Acoustical control matters such as chronic noise exposure has been shown to hinder cognitive functioning and to impair pre-reading and reading skills."

In relevance to this study on the student hostel and its basic function in providing accommodation to students, it is necessary to ensure a peaceful and tranquil ambience, especially during the nighttime. Although it is assumed that all students will be sleeping during the standard 11 pm to 7 am, the reality is far from the truth. University students' sleep hours vary by individual as the students go through the day with varying activities, be it personal, curricular, or academic driven activities.

Hence, it is necessary to manage noise and improve the acoustical condition of the student hostel indoor spaces. Additionally, the noise level can be controlled by various interior design strategies which include room shape, spatial design, sound-absorbing materials, and the placement of electrical appliances such as the air conditioning unit (Harris 1991).

Student occupants can adapt to whatever noise level existed indoors as long as it is not excessive and out of their comfort level. This is supported by an Occupancy comfort study of a Malaysian multi-storey student hostel by Dahlan et al. (2008) that shows student occupant's response towards the hostel room's indoor acoustic comfort level to be neither quiet and noisy, portraying their adaptability. However, the study also highlighted the student's concern over the hostel's acoustic condition in general. It was emphasized that acoustic condition was the second concern for student occupants in regards to their hostel indoor environment comfort parameters.

Lai (2013b) study on university student hostel facilities in Hong Kong determined that acoustic is the fourth most important aspect that student occupants expect from their accommodation. However, in their current hostel room, acoustic is ranked at number five out of six for satisfaction.

CONCLUSION

The student hostel is more than a place to sleep and eat as it offers a much-needed haven for comfort and shelter. Student's health, comfort, and satisfaction have been key components in a higher educational institution in today's competitive world. There is a significant correlation between student hostel comfort condition and student satisfaction that had impacted the declining student enrolment numbers (Khaled Mohamed Helmy 2016). Satisfied students could attract potential students' enrollment and assist with the retention of current students.

Hence, the five indoor environmental parameters; Indoor Air Quality (IAQ), Thermal Comfort, Lighting, Visual and Acoustic are significant factors that need to be investigated continuously throughout the years especially in the context of student hostels in Malaysia. The indoor environment comfort performance of student hostels is determined by the students' comfort perception and expectation of the hostel, hence, it is necessary to explore the five indoor environmental parameters and make further improvements in this area.

However, there is a scarcity of publications on student occupancy comfort surveys on student hostels in Malaysia. Most studies available are on its physical facilities aspect and services. There is a minimal study that focuses on student's comfort perception on the indoor environmental condition of student hostel in Malaysia in the recent 10 years.

Given the significance, therefore, it is a gap necessary for continuous future research to put focus on especially in the Malaysian context by monitoring the student's indoor environment comfort, and satisfaction in their hostel rooms. There should be more publications and surveys conducted in student hostel buildings in Malaysia to continuously monitor the effectiveness of indoor environmental comfort performance.

DECLARATION OF COMPETING INTEREST

None.

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