CFD Letters

Journal homepage:
https://semarakilmu.com.my/journals/index.php/CFD_Letters/index
ISSN: 2180-1363

Occupancy Comfort Evaluation in Green Building Rating Tools in Malaysia: A Comparative Review

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ARTICLE INFO

Article history:
Received 16 July 2022
Received in revised form 20 October 2022
Accepted 15 March 2024
Available online 31 July 2024

Keywords:
Occupancy Comfort; Passive Design; Green Building Rating Tool; Thermal Comfort; Visual Comfort; Acoustic Comfort

ABSTRACT

Passive design strategy is the approach that maximizing utilization of natural resources to achieve occupancy comfort which covers the thermal comfort, visual comfort and acoustic comfort while minimizing secondary energy usage. Adapting passive design strategy during building design-stage is beneficial in reducing energy load of the building for long term, furthermore to reduce the energy consumption in day to day building operation. Applying Green Building Rating Tools, GBRT promotes passive design strategy for non-residential building and will assist the building designer to comply with the local and international standard. The minimum requirement of occupancy comfort is captured in GBRT rating system with different approach and intension of the system. This review summarize the coverage of passive design strategy sectors for non-residential building in Malaysia by comparing three GBRT system namely Green Building Index, GBI NCNR, MyCREST ICSAS and GreenRE NRB system. GreenRE NRB seems more aggressive in occupancy comfort evaluation compared to GBI NCNR and MyCREST ICSAS. GreenRE allocates 48.7% of total marks focus on occupancy comfort aspect while GBI and MyCREST allocates 14% and 13.2% respectively from the total score. MyCrest had enforce the mandatory compliance of OTTV, RTTV and U_{roof} to meet baseline requirement as per MS1525:2019 with zero marks allocation. Based on marks percentage allocation, GBI and MyCrest prioritizing visual comfort while GreenRE give more focus on thermal comfort with higher marks allocation. All rating system give less focus on acoustic comfort. On average, 16.3% of marks covers the thermal comfort, 9% covers visual comfort and 1% cover acoustic comfort. GBI and MyCrest focus more on green building materials which covers the building lifecycle includes water management and waste disposal. All system contributes to Malaysia-UNFCCC ratification of Paris Agreement on 45% GHG reduction in longer runs.

1. Introduction

Feeling comfortable during working in the office room or in working area is very important to assist us to obtain full focus and concentration on what we are doing. When the employee feels comfortable in the working space, the employee will have less ill-related sickness i.e coldness, skin irritation and sweating which leads to medical absenteeism, clinical attention and reduce the

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https://doi.org/10.37934/cfdl.16.12.128139

productivity as discussed by Hangzi Wu *et al.,* [6], Xian Dong *et al.,* [7] and Md Taib *et al.,* [9]. The good comfort working environment promotes healthy employee and motivation to work efficiently and furthermore to sustain healthy working environment. Thus, employer whom accentuate the comfortable working environment and well-being will gain the soft payback in longer term. Providing the comfort working environment can be costly if the correction or modification need to be apply to the existing working space. Thus, defining comfortable working space during initial design is very important. Comfort working environment can be pre-design by applying the passive design strategy as suggested by several authors [6-9, 20-24, 26-28]. Applying passive design strategy at design stage will support the Sustainable Goal Development strategy by UN, covers the Good Health and Well-Being strategy, Affordable and Clean Energy strategy, Climate Action strategy and Life on Land strategy [29-31].

Passive design strategy is the approach that maximizing utilization of natural resources to achieve comfort standards using minimal secondary energy. For example, the sun lights can be channel as daylighting resource in the building with proper design of windows opening and reflectors placement. Thus electrical energy to lights the rooms can be reduced during daytime [22]. Also, the good ventilation space with appropriate air movement will promote natural cooling reduces the heat through convection. Reducing the secondary energy usage will assist in reducing the impact to the environment especially GHG emission, Carbon release which contribute to global warming issue as discussed by Thong Zhineng [25].

Ensuring the appropriate passive design of building, standards and rating system has been establish internationally by World Green Building Council, WGBC with alliance of 80 national Green Building Councils worldwide. Although there's many rating systems developed, but well known system for Green Building Rating or Rating Tools are LEED (US), GBI (Malaysia), CASBEE (Japan), Green Star (Australia & New Zealand), KGBCC (South Korea), Green Mark (Singapore), and Green Ship (Indonesia) as summarized by [10,12-19], . In Malaysia, this review identified 3 rating systems that covering specifically the passive design strategy which directly evaluate the occupancy comfort. The identified system specify their specific parameter or requirement and allocate the rating or point system for each level. Although there's other rating system available to promote buildings energy intensity (EEI) and building energy index (BEI) like BEI Labeling for government buildings and MyHijau Marks, but the system refers to Malaysia Standard MS1525:2019 system or other International Standard like ASHRAE or ISO 150001 as minimum qualification without specifying the strategy and rating/point.

The scope of this review is to compare and analyze the evaluation of occupancy comfort consideration in Green Building Rating Tools in the Malaysia; which is Green Building Index (GBI) NRNC v2.0, MyCrest ICSAS and GreenRE NRB v3.0. This reviews limited to new construction or pre-design stage of Non-Residential Building.

2. Relation of Occupancy Comfort and Passive Design

During building design stage, one of the most important considerations is the extent to which it provides the comfort environment to the occupants. As per international standard, the aspect of human comfort contributed by passive design are includes thermal comfort includes air quality, visual comfort and acoustics comfort. Others aspects of comfort are personal factors, health and wellbeing and ergonomics which not covered in this analysis. Passive design strategy promotes better optimization of natural resources to provide thermal comfort, visual comfort and acoustics comfort which widely discuss by several authors [6-9, 20-24, and 26]. The passive design strategy covers wide

range of strategies and can be divided into two categories which is outdoor passive design element and indoor passive design element. The Figure 1 and Figure 2 illustrates both categories.

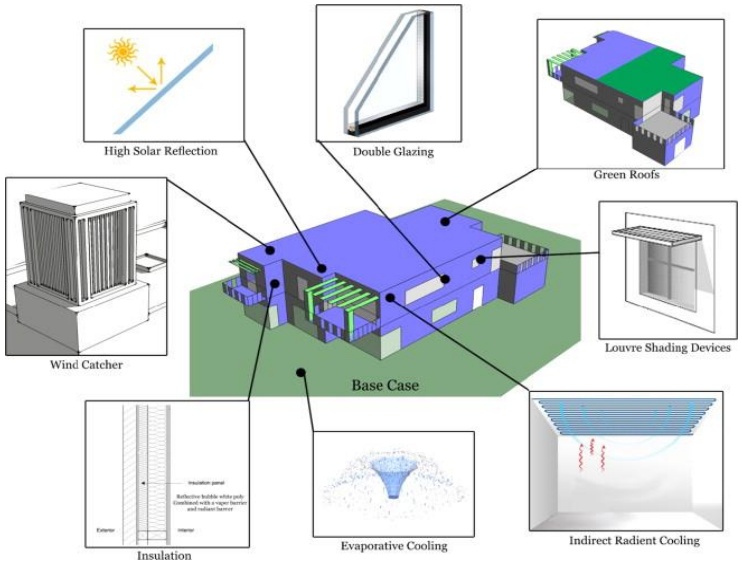

Fig. 1. Outdoor passive design strategies

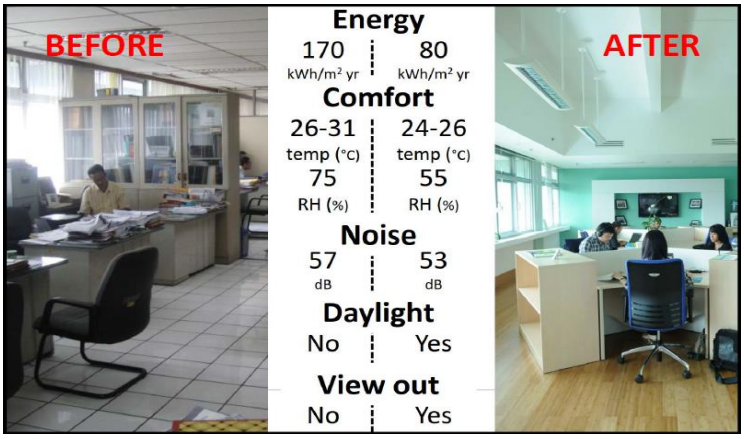

Fig. 2. Indoor passive design strategies

The outdoor passive design strategies as shown in Figure 1, mainly to improve the Overall Thermal Transfer Value, OTTV and Roof Thermal Transfer Value, RTTV, which may include building materials selection, façade and sun shading design, buildings orientation based on sunlight movement, insulation material and double glazing windows with appropriate window to wall, WWR ratio. Those strategies is very critical in reducing the conduction heat through façade and roof as well as solar heat gain through windows material and construction. These strategies was supported by Hangzi Wu *et al.,* [6], Xian Dong *et al.,* [7], Md Taib *et al.,* [9], Mohd Bakeri *et al.,* [20]. Additionally, the wall colour selection also plays a role in promoting passive design strategy in reducing the heat load. The brighter colour of the wall will reduce the heat conduction impact. The skyline daylighting reflector installation promotes natural daylighting resulting reduction of artificial lights during daytime. Furthermore, installation of wind catcher and windows opening with fins design will improve the natural cooling and promotes better air ventilation and maintain the humidity level. Nevertheless, the adaption of greenery landscaping and sun shade will optimize the cooling load of the building.

On the Figure 2, the indoor passive design promotes the actual comfort feeling of the occupants where improvement of air circulation/ventilation with calm colour will improve the working environment with lesser energy consumption as supported by Fei Xue *et al.,* [21]. Wise selection of flooring material, calm colour themes and view out preferment will reduce the work stress furthermore improve the visibility and work efficiency and the occupant still enjoying good thermal comfort with less energy consumption. On the artificial lighting, Shazmin Shareena Ab. Aziz [22] suggest the new building normally will adapt the LED type lighting with better aesthetic and comparatively cheaper than conventional fluorescent lights fixture.

3. Local and International Standard application for Occupancy Comfort

American Society of Heating, Refrigerating and Air Conditioning Engineers, ASHRAE standards [2] is widely used in international level in determining minimum parameters to achieve thermal comfort, visual comfort and acoustic comfort. In Malaysia, MS1525 system being use to benchmark the minimum requirement of energy efficient building which promoting passive design strategies in indirect-way. In this study, the system prioritize the use of MS1525 Malaysian Standard and if any missing parameters, then ASHRAE standard will supplement the standard. Based on current MS1525:2019 standard [1], the applicable standards for this study is as per Table 1 and it's categorized into cover thermal comfort and visual comfort. Since MS1525:2019 not covers the acoustic comfort, this review refers to ASHRAE standard for permissible Noise level. The thermal comfort being sub-divided into 2 section called Building envelope and ventilation and air quality. The building envelope covers any improvement related to OTTV and RTTV value. Lower OTTV and RTTV ensure the lower heat gain by the physical building either by material, orientation or glass ratio area. Additionally, the internal cumulated heat can be reject out by good ventilation setup which brings the comfortable temperature and humidity.

Table 1
Standards covering thermal comfort, visual comfort and noise

System		**ASHRAE Standard**	**MS1525 Standard**
Thermal Comfort	Building Envelope	1365-RP	Section 5.0 Building Envelope Section 4.5 Façade Design
	Ventilation & Air Quality (temperature, relative humidity, air velocity)	55 62.1 129	Section 4.6 Natural Ventilation
Visual Comfort / Daylighting		1415-RP	Section 6.0 Lighting Section 4.4 Natural Daylighting Section 5.4 Artificial Daylighting
Acoustic Comfort / Noise		1322-RP	n/a

Table 2 summarized the minimum requirement of the building design to be eligible for assessment and/or improvement prior certification. The building OTTV of design building shall be lower than 50 W/m^2 and the RTTV shall be lower than 25 W/m^2. The dry bulb temperature is limit to min of 23^{0}C and it's recommended to set the room temperature between 24^{0}C to 26^{0}C since Malaysia is in tropical climate. The relative humidity target is 50 % to 70 % and the maximum air velocity set to 0.7 m/s. On the visual comfort, lighting shall meet the MS1525:2019 Table 13 which available in the standard with the Daylight Factor, DF between 1.0%~3.5%. MS1525:2019 not provide and guideline for acoustic comfort which related to noise exposure, thus, the ASHRAE standard 1322-RP

will be refer. The permissible noise exposure will be 55dB during peak hours and 45dB during off-peak.

Table 2
Minimum Requirement determining thermal comfort, visual comfort and acoustic comfort

System		**MS1525:2019 Standard Requirement**	
Thermal comfort	Building Envelope	**OTTV** ≤ 50 W/m^2, **RTTV** ≤ 25 W/m^2	
	Ventilation & Air Quality	Dry Bulb Temp	Min: 23^{0}C (indoor) Recommended: 24^{0}C to 26^{0}C
		Relative Humidity	50 % to 70 %
		Air Velocity	Recommended: 0.15 m/s to 0.50 m/s Max: 0.70 m/s
Visual comfort / daylighting		Baseline: General: based on table 13 Acceptable DF : 1.0%~3.5%	
Acoustic comfort / noise (ASHRAE)		Peak (6am~10pm): 55dB Off-peak (10pm~6am): 45dB	

4. Green Building Rating Tools (GBRT) in Malaysia

Green building rating tools in Malaysia are developed by government and non-governmental body with specific purpose. These system are tailored made base on the interest of the developer which aligned with Malaysia ratification of UNFCCC for Paris Agreement on GHG reduction globally. Malaysia committed to reduce 45% GHG emission with some terms and condition. Considering passive design strategy in Green Building Rating Tools, GBRT during design stage may contribute in reduction of energy use for new building developments.

4.1 Green Building Index, GBI

Green Building Index, GBI [3] launched in 2009 by Pertubuhan Arkitek Malaysia, PAM and Association of Consulting engineer Malaysia, ACEM. The intention of developing this rating system is to standardize the measurement, promote integrated system includes environmental aspect and impact. This system expected to become common language on the green building rating system and promote rewards & recognition. The GBI rating tools consist of six (6) sections which is Energy Efficiency (EE), Indoor Environmental Quality (IEQ), Sustainable Site Planning & Management (SM), Materials & Resources (MR), Water Efficiency (WE) and Innovation (IN) for Non-Residential New Construction (NRNC), Residential New construction (RNC), Non-Residential Existing Building (NREB). Some detail specification being include for specific building purpose like hotel, resort, retail lot, hospital, historical building and Call Centre. The passive design strategy are covers in one (1) clause in Energy efficiency sections and ten (10) clauses in Indoor Environmental Quality section. Passive Design strategy covers 14 point which equivalent to 14% of overall scoring in GBI rating tools. In EE section, 1 points are allocated for OTTV and RTTV calculation and met the requirement of OTTV ≤ 50 W/m2 and RTTV ≤ 25 W/m2 respectively. In IEQ section, 13 point are allocated for ventilation control as per ASHRAE 55 and 62.1, control of relative humidity (RH), comfort working temperature controls, Air Change Effectiveness (ACE) calculation as per ASHRAE 129, daylighting, glaring, office minimum luminance, high frequency ballast, glaring factors and acoustic sound level. This 14 points covers the thermal comfort, visual comfort and acoustic comfort.

4.2 MyCrest – ICSAS (Integrated Carbon and Sustainable Assessment System)

Malaysian Carbon Reduction and Environmental Sustainability Tool, MyCrest [4] are launched by Construction Industry Development Board (CIDB) and Public Works Department (PWD) in 2015. MyCrest aims to expedite the green building development in Malaysia where MyCrest achieve 1.5% green building within 1 year. The intension of MyCrest is to reduce the carbon emission and environmental impact which support Malaysia ratification of Paris Agreement within the same year. The approach of MyCrest are based on carbon rating and carbon reduction calculation from Embodied Carbon system. The carbon reduction calculation being executed for every stage starts from design, construction, operation & maintenance and furthermore to waste management for newly design building and existing building. Carbon calculator tools, Carbon Impact tools and Sustainable tool being introduce in MyCrest rating tools. Integrated Carbon and Sustainable Assessment System, ICSAS checklist are develop to assist on the rating. In ICSAS, the OTTV, RTTV and Thermal Transmittance, U value for roof is consider as mandatory requirement and no marks being given. The minimum requirement is as per MS1525. Any applicant fail on this criteria, their building will be disqualify. Since the focus of MyCrest is to reduce carbon emission by reducing energy consumption, the rating is developed is based on how much energy can be reduce from the baseline calculation. Reducing the energy will leads to reduction of carbon emission. A total of 18 marks maximum being allocated for passive design strategy representing 13.3% of total scoring system. 5 marks will be awarded if the OTTV can be reduce up to 10 W/m2 from baseline, air fenestration < 0.5 scores 1 marks, Zoning lighting system with 30% auto sensor scores 3 marks, 3 marks will be awarded for >80% natural daylighting, photo sensor 1 marks, and increase of lighting power density >35% scored another 5 marks. ICSAS not covering noise comfort, and temperature and humidity aspects in thermal comfort.

4.3 GreenRE – NRB (Non-Residential Buildings)

In 2013, Real Estate and Housing Development Association (REHDA) established GreenRE rating tools as secondary GBRT in Malaysia. The GreenRE rating tools adapting the practical approach which aligned with Malaysia Government regulation and environmental promotion program from planning, design, construction and commissioning of the Non-Residential Buildings (NRB), Residential Building (RES) and Existing Non-Residential Building, (ENRB). NRB rating tools is divided into 2 category which is Energy Improvement and Green Requirement. The focus is mainly into Energy Improvement section where most critical passive design strategy is under this group. NRB mandate the minimum score of 30marks shall be pass to be qualify for next category rating which is green features. The minimum requirements of thermal, visual and noise comfort are aligned with MS1525:2019 and ASHRAE standard as in Table 2. The Energy Improvement section consist of OTTV, RTTV, daylighting, artificial lighting, ventilation Energy efficient practices and renewable energy. In green features section, the rating covers the water efficiency, environmental protection, Indoor environmental quality, green features and carbon emission calculation. GreenRE rating system promotes 96marks covers passive design strategy representing 49.7% of overall scoring. This shows the practical approach to reduce the energy consumption and environmental impacts by enhancing the coverage of passive design strategy during design stage. OTTV calculation scores 15 marks as initial calculation and additional 25marks for the improvement of OTTV, RTTV and 5 marks for improvement of thermal transmittance U value for roof. Natural ventilation of indoor and common area including car parks scores 20marks with additional 9 marks for natural ventilation improvement implementation for car park and common area. Daylighting and artificial lightings contribute 18 marks follow by high

frequency ballast 1 marks. Thermal comfort contribute 2 marks and noise comfort score 1 marks. Higher marks in GreenRE system due to simulation or modelling requirement to ensure the promising energy savings and proven by the simulation results.

5. Comparison of Occupancy Comfort Evaluation in GBRT

Occupancy Comfort evaluation are categorized into thermal comfort, visual comfort and acoustic comfort. There green building rating tools which is Green Building Index (GBI) NRNC v2.0, MyCrest-ICSAS and GreenRE NRB v3.0 has been studied and all scoring related to the passive design strategy has been analysed and summarized. This review summarize the commonality of each clause based on written requirement or standard. Under thermal comfort category, parameter considered are OTTV, RTTV, U_{roof} value, RH control, Temperature control and air velocity control. For visual comfort, the parameter are natural daylighting, sensors application, glare control and artificial lighting with HF ballast installation to reduce the flickering. GBI set the parameter of sound level to <45dB (open space) and <40dB (office), but GreenRE set the sound level of <55dB for peak hours and <45dB during off-peak. Table 3 compares each parameter and the scoring weightage by each GBRT system.

Table 3
Comparison of occupancy comfort evaluation

	Description		**GBI**		**MyCrest**		**GreenRE**	
			Point	**%**	**Point**	**%**	**Point**	**%**
Thermal comfort	OTTV ≤ 50, RTTV ≤ 25	Baseline	1	1%	mandatory		15	7.8%
		Improvement	*X*	*X*	5	3.7%	25	12.0%
	U value for roof 0.6 w/m^{2}K & 0.4 w/m^{2}K		*X*	*X*	mandatory		5	2.5%
	Meet the minimum requirements of ventilation rate in ASHRAE 62.1		1	1%	*X*	*X*	20	10.4%
	actively control indoor air humidity to be no more than 70% RH		1	1%	*X*	*X*	*X*	*X*
	-Thermal Comfort Design as per ASHRAE 55 / MS1525 -individual comfort controls for ≥ 50%		2	2%	*X*	*X*	2	1.0%
	The ventilation systems are designed to achieve an ACE of ≥ 0.95 (ASHRAE 129)		1	1%	1	0.7%	9	4.70%
Visual comfort & lighting	Natural Daylights ≥ 60% OR ≥ 75% / 80%		2	2%	3	2.2%	6	3.1%
	Reduce discomfort of glare from natural light.		1	1%	*X*	*X*	*X*	*X*
	Auto sensor covering 30% of Occupied building area. Maintains a luminance level of no more than specified in MS1525 for 90% of NLA		1	1%	4	2.9%	12	6.2%
	Install high frequency ballasts in fluorescent luminaires over a minimum of 90% of NLA		1	1%	*X*	*X*	1	0.5%
	- Daylight factor in the range of 1.0 – 3.5%. ≥ 30% (1marks) or ≥ 50% (2marks) -Artificial lighting, power density, >35%		2	2%	5	3.7%	*X*	*X*
Acoustic comfort	-Sound level < 45dBAeq for open space and < 40dBAeq for closed offices. -Peak hours <55dB & Off-peak < 45dB.		1	1%	*X*	*X*	1	0.5%
	Total		**14%**		**13.3% + mandatory**		**49.7%**	

6. Discussion

As overall, the GreenRE promoting more passive design strategy covers 49.7% of its overall system while GBI and MyCrest covers 14%and 13.3% respectively. From the Table 3, building basic design and construction material selection is plays an important roles during certification process by GreenRE and MyCrest. MyCrest noted that meeting the MS1525:2019 is mandatory and lead to disqualification, if fail. Additionally, both system promoting the high scoring for improvement of OTTV and RTTV parameter either change the building orientation, reduce window-to-wall ratio, improve glass material using low-e double glazing or improve construction material using better thermal transfer material. GBI only putting the requirement to meet the MS1525 requirement to be qualify for the marks in this section. GBI shall consider the improvement score as well as the OTTV and RTTV is the key parameter in determining the efficient use of Air Conditioning. Similar for roof thermal transmittance U_{roof}, MyCrest again make it mandatory requirement to be met while GreenRE advancing the score for improvement. Figure 3 show the weightage in term of percentage of occupancy comfort for each rating system.

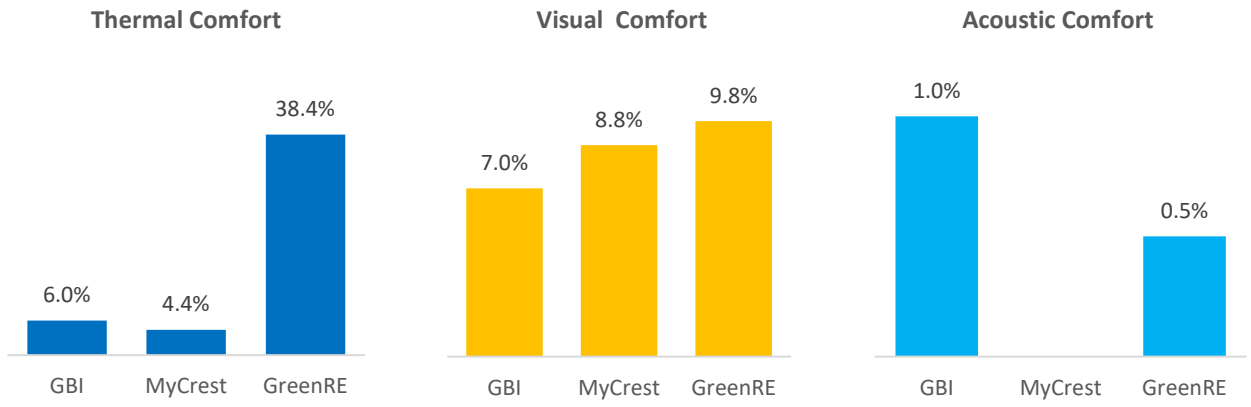

Fig. 3. Weightage comparison

6.1 Thermal Comfort

On the thermal comfort by controlling temperature, ventilation and relative humidity, GreenRE allocate 16.1% overall scoring while GBI allocate 5% of overall scoring. This interior controls factor is very important strategy to provide actual thermal comfort to the occupants. GreenRE promoting more weightage on natural air ventilation of 10.4% since Malaysia is tropical country and have quite lower average temperature through the year and good precipitation rate. Natural air ventilation will swipe indoor heat to outside by the air movement. MyCrest did not consider any natural ventilation while GBI allocate only 1% weightage for natural ventilation. All three system considering additional mechanical ventilation to maintain good Air Change Effectiveness, ACE to be more than 0.95. Adding mechanical ventilation will introduce more energy but surely to maintain the comfort of the occupant. The allocation of adding mechanical ventilation to building weightage at 4.7%, 0.7% and 1% by GreenRE, MyCrest and GBI respectively.

Maintaining comfort temperature at 23°C to 26°C, GBI allocate weightage of 2% and GreenRE weightage at 1%. Additionally, GBI allocate weightage of 1% for controls of humidity >70%. MyCrest and not allocate any score for these 2 factor. As observed, looking at temperature and relative humidity point of view are insufficient as all three rating system had covers the temperature & humidity control through separate Air Condition & Mechanical Ventilation, ACMV system in Energy

Efficiency section. The ACMV system is more related to energy efficiency strategy compared to passive design strategy. Thus, by complying to EE strategy for ACMV system will definitely satisfying the thermal comfort due to temperature and humidity control. For example, GreenRE allocate a weightage of 10.4% in AC system design with additional 7.7% for MV system design.

6.2 Visual Comfort

For visual comfort, the discussion will covers the provision of natural daylighting, glaring, artificial lighting and lighting control system. Natural daylighting promote uses of sun light as main source of daylighting in the building by installing window and reflector. It's free energy and always available on daily basis. But some days, we might having high precipitation rate and rain as well where the natural daylighting is decrease. To ensure the comfort of visual, sufficient luminance shall be made available with combination of natural daylighting and artificial lighting. The scoring for natural daylighting is almost the same for all systems at 2%, 2.2% and 3.1% for GBI, MyCrest and GreenRE respectively. Additionally, in maintaining good lighting system, GreenRE allocate higher additional weightage of 6.2% compare to MyCrest 2.9% and GBI 1%. In this rating the system promoting auto occupancy sensor and perimeter sensor covering 90% of Net Lettable Area, NLA. To ensure there's no disturbance of lightings system due to flickering, GBI & GreenRE allocate 1 points for high frequency, HF ballast installation. Only GBI considering the glaring issue due to natural daylight reflection in the GBI scoring system. GreenRE promoting better sun shading approach to resolve the glaring issue without allocate any point against it.

6.3 Acoustic Comfort

Acoustic Comfort is another parameter that need to be taken into consideration for occupancy comfort. High noise will disturb the concentration and focus. Exposing our eardrum for longer period of uncontrollable noise might affects the eardrum in longer term. GBI set the noise level to <40 ~ <45dB in open space and in office respectively while GreenRE set the noise level according to working hours which is peak hour at <55dB and off-peak hours at <45dB. MyCrest not allocate any clause to cover the acoustic comfort. Both GBI and GreenRE allocate 1 point for this clause. Although in this rating system not stressing much on acoustic comfort, the construction standard, construction health and safety standard is definitely covers this point.

7. Conclusion

Implementing Passive design strategy during design stage will promote the sustainable building design to be more natural-friendly building and consume less energy. As result, the GHG emission and carbon emission will be reduce and global warming effects can be reduce over the time. Occupancy comfort which set by MS1525 Malaysian Standard and ASHRAE Standard still can be fulfil while adapting passive design strategy. Furthermore, the building owner enjoys the soft-benefits in long run resulting the higher health performance of his employee. The human comfort factor is properly defined in Malaysian Standard MS1525:2019 and ASHRAE standard where both standard being referred as minimum requirement to be achieve while implementing the green building rating based on their approach. Thus, the result for any rating will represent actual occupancy comfort for that building.

These 3 systems being develop in such a way that aligned with Malaysian government action plan to adapt National Energy Efficiency Action Plan 2016 (NEEAP) and fulfilling the Paris Agreement 2016

ratification to UNFCCC. The system selected for this analysis is fulfilling the Malaysia green building plan as all systems are actively certifying many building in Malaysia including government offices based on their rating and rating system. The availability of more than one rating systems creates options to building owner either government or non-government organization. At early stages, GBI is popular for government buildings as the GBI's tools is highly recommended by the ministry with incentive and better promotion. The use of GBI tools in expanded to commercial building sector and reach to 1,165 applications in June 2022 and whereas Certified buildings reach 619 units. GreenRE certified a total of 200 buildings as 31st August 2022 with total application of 344. MyCrest launched by CIDB in 2015 not shows any certification statistic in their website. The popularity of GBI mainly due to government involvement and enforcement as part of NEEAP program while GreenRE is non-government organization whom collaborate with Singapore's Green Building Council, SGBC on the implementation and knowledge sharing. The Malaysian government empower building owner to adapt greener building regardless the certification tools used to access their building where Sustainable Energy Development Authority Malaysia, SEDA under Ministry of Energy and Natural Resources (KeTSA) gives many incentives and launching many program promotes the greener environment includes Energy Star electrical appliances incentive, International Sustainable Energy Summit (ISES) 2022, Sustainable Energy Forums and many conferences. Similarly, GreenRE scheduled annual training program, experts sharing session and Green Building Conference, GBC which publish into their website. As building owner, the selection might be made by considering the popularity of the GBRT tools and certification cost. In future review, researcher may consider the factor affecting the GBRT selection in Malaysia and provides the propose factors of selecting the GBRT tools either by commercial factor, popularity, government decision or cost factor.

Despite the different weightage scoring of passive design strategy in all GBRT system, the rating of system will lead to improving the green culture in Malaysia and the importance of adapting the greener facility in day-to-day activities. As effective green building perspective, this review suggest GreenRE as best GBRT which can deliver higher greener opportunity in many aspects and parameters.

Acknowledgement
This research was funded by a grant from Universiti Tun Hussein Onn Malaysia (RE-GG Grant UTHM/PS/500-19/7).

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