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Green Building Certification and Its Correlation to Building Energy Index: Malaysia Commercial Green Building

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Abstract. Green building is the spine of the Sustainable Development Goals. It is supported by their rating tools that cover energy efficiency as a part of the indicator. The paper authored to identify design efficiency of green buildings in terms of energy performance. Therefore, the value of Building Energy Index for each building and level of association between Building Energy Index and tier points of green rating for buildings will be identified using correlation value. The first objective is to calculate the Building Energy Index of the commercial green building using the standard formula of MS1525:2019. Secondly is to calculate the correlation between the Building Energy Index and total tier of green rating certification points. All buildings consist of office, retail, industrial and institution buildings were analysed are under the average standard of MS1525:2019. Tier of green rating certification points divided to Platinum, Gold, Silver and Bronze rankings. In contradiction with the total tier points of green rating, it is found that the higher the tier points, the better the Building Energy Index of a green building as the correlation results between Building Energy Index and tier point of green rating indicates the negative correlation relationship for the case study covering different types of building at 0.57.

Keywords: tier of green rating; building energy index; commercial green buildings

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INTRODUCTION

There are several building green rating tools such as GBI, GreenRE, MyCREST, Melaka Green Seal and PHJKR which were introduced in Malaysia since 2009. The main objective of these green rating tools is to achieve triple bottom line of sustainability, which are social, economic and environmental [16]. Besides that, green rating tool becomes part of the green building assessment process [22]. Therefore, without green rating tools, assessment of the green building process is not complete. Viewing this perspective, in Malaysia itself, total gross floor area of 21.2-million-meter square by GBI [23] and 4.6-million-meter square by GreenRE [21] are already certified in the year 2019 for residential and non-residential buildings in Malaysia. This is aligned with the introduction of 2030 Sustainability Goal that aim reduction of 25% of the gross electricity usage by building sector. In Malaysia, the biggest contributor to rising CO2 levels is the use of fossil fuels for power generation. 90% of Malaysia's energy mix is produced from fossil fuels (i.e. coal, gas and oil). Malaysia also aims at decreasing 45% of the CO2 emissions per GDP by the year 2030 [27]. Besides that, The Paris Accord has set a target to limit global average temperature to within 2 degrees Celsius of pre-industrial levels. Major focus in on limiting greenhouse gas emissions measured in tonnes of CO2 equivalent (tCO2eq) [26]. In Malaysian, there are a lot of consequences and losses due

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to climate changes such as wastage to economy and ecology. Besides that, losses also occurred to land and coastal habitats and increased flood risk to the nation which can cause severe damages to infrastructures [29].

BUILDING ENERGY INDEX AND TIER POINTS OF GREEN RATING

Pandey [1] highlighted that 30 to 40% of total energy utilisation were from building operations. He also claimed that 70 percent was by electricity consumption. These signify the relationship between the green building and environmental burden. It is believed that through the practice of energy efficiency concept of green building, this burden can be reduced. This paper aims at assessing the relationship between tier points of green rating and building energy index for commercial green building. The first objectives of this paper are to calculate the Building Energy Index of the commercial green building. Secondly, is to calculate the level of correlation between Building Energy Index and total tier points of green rating in buildings. Based on the outcome, this paper explores the context of commercial buildings that focus mainly on green commercial building, particularly on the Building Energy Index. Moreover, this paper analyses twenty-four (24) buildings. The scope of calculating type of energy is limited to the building electricity consumption only.

Green Building Energy Index

The concept of green building involves the reduction of energy consumption, adverse environmental and occupational health impact, increase use of green materials and improve productivity for the whole life cycle of a building [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 19]. Primary sustainability theme in the Malaysian green building rating tools includes indoor environmental quality (IEQ) and energy efficiency. The IEQ takes into account carbon dioxide monitoring and control.

Green building rating tools have proliferated the market to drive improved building performance in Malaysia. These rating tools cover three (3) main pillars, namely resource conservation, reduced environmental impact and improved occupant
wellbeing. GreenRE and GBI are the most popular tropical centric green building rating tools in Malaysia. Energy efficiency is the main pillar of focus for both these tools with up to 50% of points for GreenRE and 35% for GBI. Energy efficiency is the low hanging fruit in tackling both the effects of global warming and improving operational efficiency resulting in savings for building users [24].

Nowadays, the non-residential green building established rapidly in both developed and developing countries to meet sustainable planning for the built environment [4, 7, 11, 12, 13]. The hike of interest among investor, in building a green building simultaneously contributes to the economic growth of a country [12, 14]. Thus, this highlighted that green building provides benefits to pillars of sustainable development. A commercial building is "*a building that is used for business activities*". Therefore, for the purpose of this paper, data were collected from both workplace and shopping malls with the size 822.1m^2 to 126,793 m^2 net floor area. In comparison with conventional buildings in Malaysia, the ranges of BEI found are between 100 to 450 kWh/m^2/year. About thirty per cent (30%) of the building's consumption is below the benchmark of an energy efficient building standard [15]. The level of energy consumption among green energy buildings in Malaysia is still unknown until today. Thus, this paper's findings are to fill this gap.

Tier Points of Green Rating Tool

The existence of green rating tools will be able to reduce the level of impacts caused by buildings towards human and environment in the area of methods, task and expertise [21]. The existence of green rating tools had helped the development of green buildings across the world. Besides that, it is also was used for design comparison of conventional and green building and the method to distinguish between the green features [20]. Generally, there are list of various categories used in green rating tool for calculating the total tier points of green rating certification which are, 1) Sustainable Sites 2) Water Efficiency 3) Energy & Atmosphere 4) Materials & Resources 5) Indoor Environmental Quality 6) Innovation & Design Process 7) Regional Priority 8) Location & Linkages 9) Awareness & Education 10) Health and Well-being 11) Waste Management 12) Transport 13) Management Process 14) Pollution 15) Service Quality 16) Culture and perceptual aspect 17) Social and Economic aspect 18) Innovation & Design Process 19) Ecology [18]. In Malaysia, one of the leading green rating tools, GreenRE calculates the tier

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points of certification in four ranking, Platinum, Gold, Silver and Bronze. GreenRE has explicit performance requirements for building façade design (i.e. OTTV <42 W/m2 for Gold and <40W/m2 for Platinum), air-conditioning performance and lighting efficiency to tackle the major energy consumers in a typical building [25].

RESEARCH METHODOLOGY

Data were gathered from twenty-four (24) nos. of green buildings. The commercial green building information is as listed in the following Table 1 as follows: -

TABLE 1. Green Building Information

No.	Building Type	Location	Gross Floor Area (m^2) excluding carpark	Green Rating/Tier Certification
Building 01	Office	Selangor	14,087.67	GBI/Platinum
Building 02	Office	Kuala Lumpur	52,271.75	GBI/Platinum
Building 03	Retail	Kuala Lumpur	126,793.35	GBI/Certified
Building 04	Retail	Selangor	107,072.00	GBI/Silver
Building 05	Office	Kedah	822.10	GreenRe/Platinum
Building 06	Office	Kedah	2,449.50	GreenRe/Platinum
Building 07	Retail	Selangor	20,316.00	GreenRe/Bronze
Building 08	Office	Kuala Lumpur	41,389.00	GBI/Platinum
Building 09	Office	Johor	3,210.00	GreenRe/Bronze
Building 10	Office	Kuala Lumpur	17,004.00	GreenRe/Gold
Building 11	Office	Kuala Lumpur	98,348.00	GBI/Platinum
Building 12	Industrial	Johor	42,448.00	GreenRe/Gold
Building 13	Office	Kuala Lumpur	30,532.00	GreenRe/Bronze
Building 14	Office	Kuala Lumpur	106,825.00	GreenRe/Gold
Building 15	Office	Kuala Lumpur	78,710.00	GreenRe/Gold
Building 16	Office	Kuala Lumpur	76,497.00	GreenRe/Gold
Building 17	Office	Kuala Lumpur	55,928.00	GreenRe/Gold
Building 18	Institution	Johor	16,046.67	GreenRe/Gold
Building 19	Office	Kuala Lumpur	203,477.00	GreenRe/Platinum
Building 20	Office	Penang	13,889.37	GreenRe/Bronze
Building 21	Office	Kuala Lumpur	28,332.40	GreenRe/Silver
Building 22	Office	Kuala Lumpur	73,163.32	GreenRe/Gold
Building 23	Office	Kuala Lumpur	45,952.00	GreenRe/Platinum
Building 24	Office	Kuala Lumpur	2896.16	GreenRe/Gold

Specific energy consumption of a building being assessed by using an international standard, namely, building energy index. This determines the building yearly usage of all types of energy with exception of renewable energy generated. The outcome must with the unit of $kWh/m^2/year$.

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The formula is as follows: -

$$\text{Building Energy Index} = \frac{(\text{TBEC-CPEC}) \times (52)\ (\text{WOH})}{\text{GFA excl. car park}}$$

Where,

TBEC denotes Total Energy Building Consumption in kWh/year,

CPEC denotes Car Park Energy Consumption in kWh/year,

GFA denotes Gross Floor Area in m^2 and

WOH denotes weighted weekly operating hours [17]

There is also an establish standard by MS1525:2019 stating that the baseline for energy consumption as 200 kWh/m^2/year (Office), 300 kWh/m^2/year (Retail), 250 kWh/m2/year (Hotel/Mixed), 200 kWh/m2/year (Institution) and 300 kWh/m2/year (Industrial) in order to be acknowledged as an energy efficient building. A typical office building in Malaysia that is benchmarked to MS1525 has a building energy performance of between 200-250 kWh/m2/yr. A typical retail building in Malaysia that is benchmarked to MS1525 has a building energy performance of between 300-350 kWh/m2/yr [17].

The second objective is to identify the level of correlation between BEI and tier points certification of green rating. As for first objective had been fulfilled by the above method of calculation to identify the level of BEI, thus, the second objective was then achievable through drawing the scattered diagram in order to understand the correlation between BEI and tier points certification of green rating.

The formula is as follows: -

$$\text{Correlation} = \frac{\text{Covariance (A, B)}}{\text{Standard Deviation A} \times \text{Standard Deviation B}}$$

Where

A = BEI

B = Tier points certification of green rating [28]

FINDINGS

TABLE 2. Building Energy Index and Baseline of Energy Consumption by MS1525:2019

Building Name	Building Energy Index (kWh/m^2/year)	Building Categories	Standard MS1525:2019
Building 01	133.00	Office	200
Building 02	97.53	Office	200
Building 03	299.00	Retail	300
Building 04	236.10	Retail	300
Building 05	115.42	Office	200
Building 06	99.22	Office	200
Building 07	198.64	Retail	300
Building 08	122.44	Office	200
Building 09	135.23	Office	200
Building 10	94.00	Office	200
Building 11	86.84	Office	200
Building 12	316.78	Industrial	300
Building 13	151.38	Office	200
Building 14	80.82	Office	200
Building 15	99.53	Office	200
Building 16	97.89	Office	200
Building 17	246.80	Mixed	250

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Building Name	Building Energy Index (kWh/m^2/year)	Building Categories	Standard MS1525:2019
Building 18	58.36	Institution	200
Building 19	111.54	Office	200
Building 20	57.33	Office	200
Building 21	161	Office	200
Building 22	69.55	Office	200
Building 23	60.58	Office	200
Building 24	173.65	Office	200

The finding based on Fig. 1 shows that the average building energy index (BEI) is 137.61 kWh/year/m^2. However, the most energy efficient building is Building 20 at 57.33 kWh/year/m^2 where its function is more towards office building. The highest energy consumption is Building 12 at 316.78 kWh/year/m^2 which exceed the baseline of energy consumption. This building is an industrial building at 42,448m^2 GFA. All the analysed building under the baseline determined by MS1525:2019.

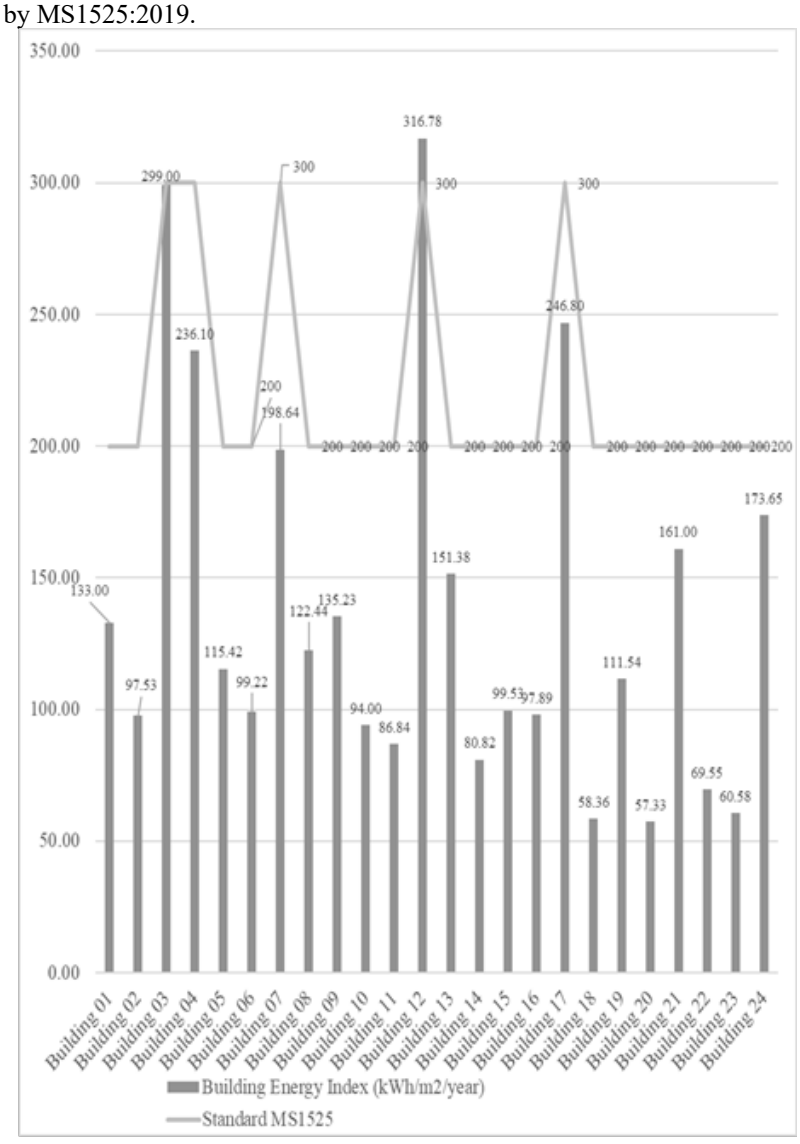

FIGURE 1. Building Energy Index and Baseline of Energy Consumption by MS 1525:2019 for Buildings in Malaysia

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TABLE 3. Building Energy Index and Tier Certification Points for Buildings in Malaysia

Building Name	Building Energy Index ($kWh/m^2/year$)	Certification Tier Points
Building 01	133.00	92.00
Building 02	97.53	93.00
Building 03	299.00	50.00
Building 04	236.10	66.00
Building 05	115.42	104.65
Building 06	99.22	95.50
Building 07	198.64	63.76
Building 08	122.44	86.00
Building 09	135.23	58.20
Building 10	94.00	86.00
Building 11	86.84	94.00
Building 12	316.78	85.59
Building 13	114.68	88.42
Building 14	151.38	77.60
Building 15	99.53	90.70
Building 16	246.38	85.25
Building 17	58.36	100.00
Building 18	111.54	86.15
Building 19	57.33	118.03
Building 20	161.00	82.72
Building 21	69.55	77.25
Building 22	60.58	85.00
Building 23	97.90	111.50
Building 24	173.65	92.7

The following Fig. 2 shows the correlation chart between the Building Efficiency Index with tier certification points for different types of buildings. It indicates negatively correlated at 0.57 as the BEI improves, the total tier points of certification will increase.

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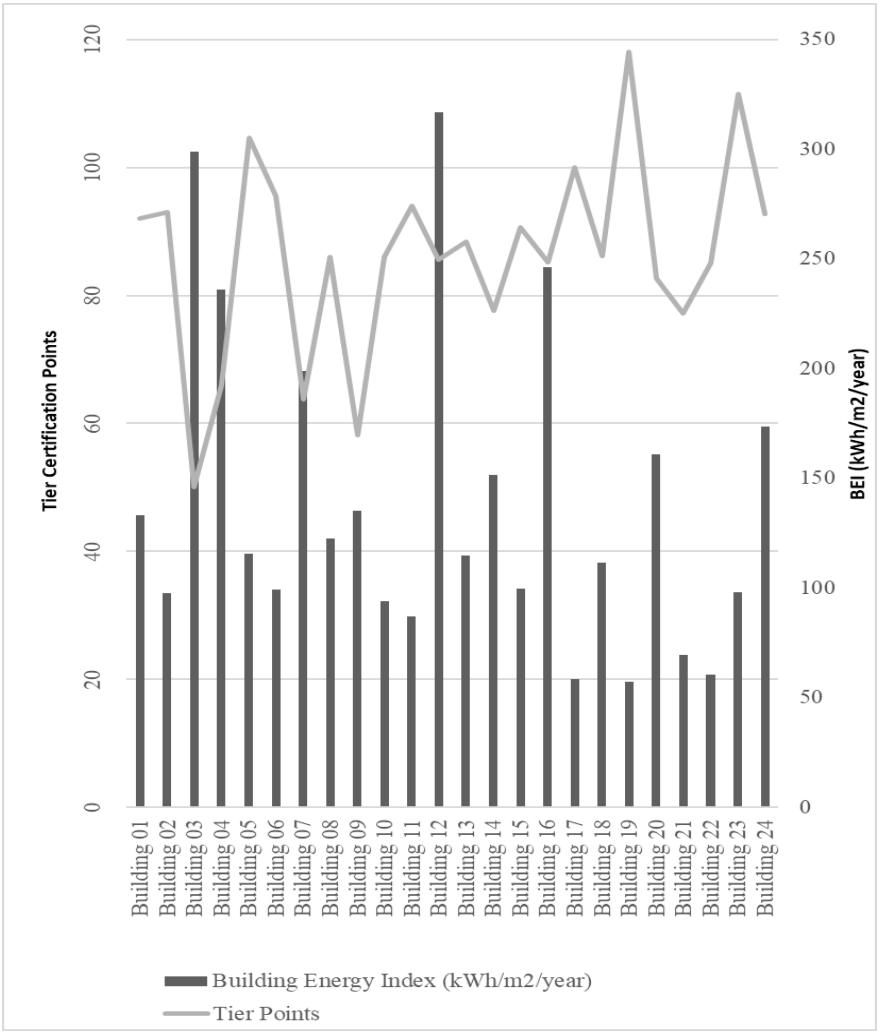

FIGURE 2. Correlation between Building Energy Index and Tier Certification Points for Buildings in Malaysia

CONCLUSION AND RECOMMENDATION

Data were gathered in order to obtain the correlation between energy efficiency and total tier points of green rating certification of all twenty-four (24) commercial green buildings. All the twenty-four buildings categorize into five categories, office, retail, industrial, mixed and institution. It is clearly drawn in figure 2 that BEI and total tier points of certification are negatively correlated at 0.57 or 57%. Thus, it can be interpreted that the energy efficiency of a building influences the total tier points of green rating certification and its ranking where lower the level of BEI, the higher the tier points of green rating certification. Although the percentage of correlation is only 57%, it is sufficient for conclusion in terms of correlation between BEI and tier points for a research study. Besides that, it is to be understood that BEI achievement is not the only criteria used for evaluation of a green building. There are several other factors considered in green rating certification process before a building is being awarded points based on Platinum, Gold, Silver and Bronze ranking. Therefore, high levels of percentage in correlation between BEI and tier points of certification is not possible. This research study once completed will benefit overall parties in green construction. This research study also able to provides information and guidance to clarify the vague among the green construction stakeholders regarding the importance of obtaining a good BEI value in achieving high level of tier points certification of green rating for their respective building. It is also to be concluded that achieving a lower BEI value will ensure a higher tier points for green rated building. In future, there are several suggestions to improve

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the research study as will overcome the current loopholes and limitations. Currently, quantitative method was selected for design and data analysis. Therefore, more building profiles need to be evaluated than the current numbers of twenty-four (24) as will reveal a better convincing result in terms of correlation value between BEI and tier points of buildings rated by green rating tool. Besides that, combination of several research methods are highly recommended for obtaining the responses or perception in detail about relationship between BEI and tier points of buildings rated by green rating tool.

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