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Influential factors to occupy green residential building among green building occupants

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Abstract

Green building has been proven having higher occupancy rate than conventional building. The occupancy rate of ENERGY STAR and LEED-certified green office building are 8% to 18% higher than conventional office building. Previous research has proved that occupants prefer to occupy green office building due to various green benefits. However, most of these researches were conducted on green office building. Therefore, this study is motivated to identify the influential factors for occupants to occupy green residential building. The aim of this study is to evaluate factors that influence occupants to occupy green certified residential building. 75 questionnaires were distributed among occupants of green certified residential building namely Molek Pine 4 and Ponderosa Lakeside Apartment in Johor Bahru. The results were analysed using frequency analysis. Location and good environment quality are the most significant factors that influence occupants to occupy the green certified residential building in Johor Bahru. This research is noteworthy for property industry players especially property developer in guiding the direction of green residential building development in accordance with occupants' and market preferences.

Keywords :
Green residential building, occupancy rate, factors, location, green building index (GBI)

1 Introduction

Residential building is able to provide shelter, comfort, and host of other amenities to their occupants. The increasing population has inevitably generated more demands on residential. According to Chen (2000), the study estimated that Malaysia needs a total of 8,850,554 houses between the years 1995 to 2020. Demands on residential eventually cause a rise in energy cost and threat to global warming. Therefore, Malaysia National Housing Policy has taken several actions in reducing carbon emission by 40 per cent before 2020 as stated in Eleventh Malaysia Plan (2016-2020).

Green residential buildings provide several benefits in economic, environment, and social. In economic aspects, green residential building can enhance energy efficiency by saving energy, optimizing the use of resources and reduce carbon emissions (Song et al., 2018). As stated in Green Technology Master Plan (2017-2030), Malaysia Government is targeting between 550 buildings in 2020 and 1,750 buildings in 2030 to be certified by a green building rating tool (Zhang et al., 2018). Presently, there is numerous certified residential building development in Malaysia. According to World Green Building Trends (2016), green building trends and demand are estimated to double every three years based on a survey conducted in 69 countries.

The past decade has endorsed an increment interest in green building concept and practices across the world due to the demand for more green building (Gou and Xie, 2017). Generally, green buildings are associated with a high occupancy rate. The occupancy rate for green building is 2%-4% higher compared to a conventional building (Miller et al., 2008). The findings of the previous research also reported a 30% of lower operating expenses was based on energy costs. The occupancy rate of LEED-certified office building has been proven by previous researchers (Fuerst and McAllister, 2009; Devine and Kok, 2015; Simcoe and Toffel, 2014). According to Fuerst and McAllister (2009), the occupancy rate of a LEED-certified office building has 8% higher. Meanwhile according to Devine and Kok (2015) has proved that the LEED-certified green office building has 8.5% of occupancy rate than a conventional building. According to Simcoe and Toffel (2014) and Wiley et al. (2010), the occupancy rate of the green office building is at 10% and 16%-18% relatively compared to the conventional green office building. Meanwhile, the occupancy rate for ENERGY STAR certified office building has 3% of high occupancy rate compared to the conventional office building (Fuerst and McAllister 2009). Meanwhile, Wiley et al. (2010) states that the occupancy rate of ENERGY STAR certified office building has 10%-11% higher than a conventional building. Therefore, it can be concluded that the occupancy rate of green building is associated as a high occupancy rate. Based on the literature review, it was found the factors influences occupants to occupy green office building are less water and energy consumption, good indoor environment quality, good corporate image, and strategic location of the building (Geng et. al., 2019).

However, previous researchers only focus on the factors that influence occupant to occupy green commercial office building. There is no research conducted on factors that influence occupants to occupy the green residential building as in Johor Bahru.

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Therefore, this study is conducted to identify the factors that influence occupants to occupy the green residential building. This research is significant to a few involved parties such as developer, occupants of green residential building and governments. This study helps to encourage more investors or developer to develop green residential building which tallies with the occupant's preferences. This research also helps the government to encourage more enterprise and industrial construction to invest in green residential building.

2 Green building

The green building was formally presented at the United Nations Conference that has been held in Rio de Janeiro in 1992. It is established in the reasons of reducing greenhouse gas emission and energy consumption significantly. According to US Green Building Council, green buildings are structures designed to promote efficient use of the resource of energy, water and materials while reducing the adverse effects of buildings on the environment. Theoretically, green building can provide healthy, comfortable, and safe living, working, and activity space for occupants (Zhao et al., 2015). In addition, researchers pointed out that green building is the practice creating structures and using processes that are responsible and resource efficient throughout a building's life cycle from siting to design, construction, operation, maintenance, and renovation (Olubunmi et. al.,2016; Circo,2007). Furthermore, Wang et al. (2015) defined green building as one that is energy and resource-efficient to sustain building's life cycle operations, at the same time being beneficial to the health and comfort of its occupants. Kozlowski (2003) supported that green building could utilise a careful incorporated design which could minimise the energy consumption, maximise the natural lightning entering buildings, thermal comfort in the buildings, and a high level of indoor air quality. Meanwhile, Elias et al. (2013) believes that green buildings need to be designed in specific ways to fulfill the requirements. It needs to be designed to save energy and resources, recycle materials, and minimize the emission of toxic substances throughout its life cycle and must be suitable with the local climate, traditions, culture and the surrounding environment.

Essentially, main scope of green building can be divided into three categories of environmental, social, and economic by referring to sustainability pillars. Principally, the energy consumption of a residential building is more than the other types of building by 70% of carbon emissions (Li et al., 2016). The carbon emission affects the physiological and physical health of occupants. Thus, green building is needed to reduce carbon emission globally.

2.1 Green building index

In Malaysia, the Green Building Index (GBI) for green building has been set up by Malaysia Institute of Architects (PAM) and Association of Consulting Engineers Malaysia (ACEM) (GBI, 2016). As mentioned by GBI, the assessment criteria act as a key tool to evaluate and compare green buildings, where provides systematic frameworks for specifying performance criteria, thereby enabling actors in the building industry to be efficient on the movement towards more sustainable form of design, constructing, and operating building.

As Malaysian has launched the Green Building Index in 2009, it is the first universal rating system which to evaluate the environmental design and performance of green buildings (Illankoon et al., 2017). As of 31st December 2020, GBI certified building report has summarised that a total of 563 green buildings were certified and 209 from 563 certified buildings (37%) were residential building. According to their website, Green Building Index (GBI) is a widely recognized rating tools for green building in Malaysia where it promotes sustainability related to environmental matters and responsibilities towards the following generations including practitioners and public. Green Building Index rating tools evaluate 14 categories of property in Malaysia such as Non-Residential New Construction (NRNC), Residential New Construction (RNC), Non-Residential Existing Building (NREB) and Industrial Existing Building (IEB). The building needs to be evaluated by GBI rating system to achieve the qualifications to be certified as a green building by GBI. In Green Building Index rating system, there are six main of green criteria which are energy efficiency (EE), indoor environmental quality (EQ), sustainable site planning and management (SM), materials and resources (MR), water efficiency (WE), and innovation (IN). Essentially, as stated by GBI, assessment criteria for each green development will be focused on these tools which explained the points required for each proposed building to achieve green certification which are platinum, gold, silver, and certified.

2.2 Green residential building

The green residential building is part of green development and green buildings. A green residential building is different from the general green building as it was inclined to adopt environmentally friendly technology with the initiative of the government. Practically, green residential has focused on house's resources which can be controlled for saving and being polluted. However, green residential development is a complicated process with multiple organizations and social background involving developers as key stakeholders who play an important role throughout the whole process (Qian et al., 2015). Besides, it is also an architectural concept with meet the modern development requirement (Li et. al., 2018). The green residential building development of the whole process is controlled by the elements of the efficient resources, environment, and technology. However, Yang et al. (2018) has identified influential factors affecting green residential building development using social network analysis method which are local economy development level, development strategy and innovation orientation, developer's acknowledgement and positioning for green residential building development, and experience and ability for green residential building development.

Essentially, green residential building can indirectly sustain and improve the quality of human life whilst maintaining the capacity of the ecosystem by local and global levels. Nowadays, there are a lot of promotions and campaigns on green has been exposed to the public for the purpose of human survival as circumstances are getting more serious when a lot of natural disasters coming up presently (Elias et al., 2013).

3 Factors that influence occupants to occupy green residential building

3.1 Affordability

According to Mulliner et al. (2013), affordable housing and sustainable development become a major problem facing by the United Kingdom and other countries. The study also mentioned that affordability of green residential building usually assessed in terms of economic viability. Housing expenditure and household income is the way to look onto the green residential affordability internationally (Hulchanski, 1995; Kutty 2005). Sustainability and affordability are intertwined. A green residential building can be defined as a house implemented with sustainability features with a reasonable price. Green development required more affordable price to encourage potential buyers to occupy the green residential building. A research in Australia has proven that green residential building positively benefits life, health, and happiness of the occupants which are the main factors influencing buyer's decision on buying green residential building (Dale Newman, 2009). However,

previous research found that green residential owners were willing to pay more in order to extent at variance aspects of environmental performance in sustainable residential development (Yam McGreal, 2010). Meanwhile, a study in Nanjing, China showed that affordability is the main factors influence occupants to occupy the green residential building (Hu et al., 2014). The study found that only rich people are prepared to pay a premium to enhance living comfort. Results of the study mentioned that there is three income level of occupants which are lower middle class, middle class, and upper-middle class. This factor was supported by Jenks (2000) where affordability by income level of occupants' effect on the demand for good living quality. Therefore, affordability is one of the factors that influence occupants to occupy the green residential building.

3.2 Reduce utility bills

Market price of green residential building is higher than conventional building due to the materials and green technology used. However, green residential building provides lower maintenance and operating cost in long term period (Alias et al., 2010). Green residential building can reduce utility bills of occupants due to the benefits of green components in water and energy efficiency. Besides, green components implemented on the green residential building such as green roof, solar photovoltaics, and green wall contributed to energy and water savings (Azis, 2021; Ran Tang, 2017; Rosas-Flores et. al., 2019; Pradhan et. al., 2019). These benefits are directly to be enjoyed by the occupants of green residential building. Despite that, this factor was proven by Yau (2012) which the researcher mentioned that green residential building has benefit in reduced utility's bills of occupants. This factor has supported by (Portnov et al., 2018). As the findings of the study in Israel was reported that each percentage point of expected maintenance savings increased by 0.3% of the price of the residential. According to Moore et al. (2017), the occupants of the green residential building had about 45% - 62% less electricity. This lower utility bills resulting in the occupant's financial savings is $1,050 per year.

3.3 Energy consumption

According to Refahi and Talkhabi (2015), heating and cooling of the conventional building was approximately 40% for energy consumption in the world. On top of that, the Department of Energy in United Stated has estimated that the occupants of residential building spend approximately 8%-14% of the income on the energy expenditure. This was due to the demands of heating and cooling needs (Zhao et al., 2018). A study in Sweden found that the energy consumption factor is the determinants factors that influence occupants to occupy the green residential building (Zalejska-Jonsson, 2014). The study found that the occupants were prepared to pay 5% premium for the low energy building. Empirically, the integration of green envelops component practices by green building have been proven to reduce energy consumption in efficient way, particularly in hot climate country (Al-Saadi et al., 2017; Mohamed et al., 2015; Taleb, 2014). As mentioned by Azis (2021), green residential buildings have potential to improve annual saving by 18%–25% for cooling loads, and 5% for lighting loads where the improvements for household electricity bills could save by approximately USD13 to USD171 annually. Meanwhile, in Hong Kong, both green and conventional occupants preferred to pay more on energy consumption than noise level reduction or water conservation (Chau et al., 2010).

3.4 Health

factors that influence occupants to occupy the green residential building is health. Health as a human being is important as everyone wants to be healthy. Thus, there are occupants who have the awareness to achieve a healthier life by occupying the green residential building. About thirty years of public health science have indicated that buildings play an important role in the shaping of occupant's health (Mendell et al., 2002). Residential building has the power to create conditions that are harmful or conducive to the occupants. Thus, the residential selection is important to occupants. In addition, researcher found that green residential building occupants place premium value on better health condition (Guo et al., 2010). Moreover, green residential buildings have been proven to provide good comfort and health in terms of living space for the occupants (Liu et al., 2019).

3.5 Location

Location is a general factor for the occupants to purchase the property that near or closes to their workplace and enjoy during the free time. According to Źróbek et al. (2015,) location was largely influenced occupants by the financial standing, preferences, needs in terms of personal circumstances to occupy the certain residential building. Apart from that, Portnov et al. (2018) concluded that green buildings are sufficiently attractive only if located in good neighbourhoods. Besides, Li et al. (2016) pointed out that location is the most concerns elements for Chinese when they choose residences. The study mentioned that Chinese chosen locations factors rather than green buildings features. This factor was supported by Hu et al. (2014) where location of the green residential building that close to the workplace is the factors influence occupants to occupy the green residential building. The study shows that the location of the green residential building in a central city and well developed becomes a choice to occupants.

3.6 Good environmental quality

Green residential building provided a comfortable and healthy living environment based on the environmental indicators (Liu et al., 2019). Besides, a good environmental quality of green residential building gives happiness and harmonious the life of the occupants where a researcher by Hu et al. (2014) has been mentioned on these factors. The results of the study have been confirmed that occupants of greuality than saving energy. In the study area, traffic and the heavy industry are the main causes of air pollution. On top of that, findings from Tan and Goh (2018) have concluded that one of main factors influencing owner's purchase intention towards green residential buildings is environmental concern. Therefore, the occupants want to find good environmental quality for good health. Thus, healthier environment is the causes selling point of the green residential building.

Table 1 In civil engineering applications

Factors	Sub-factors	Authors
Affordability	• Price range	Mulliner et al. (2013), Hulchanski (1995), Kutty (2005), Dale and Newman (2009), Yam and McGreal, (2010), Hu et al. (2014), Jenks (2000)
Reduce Utility Bills	•Maintenance savings	Alias et al. (2010), Yau (2012), Portnov et al. (2018), Moore et al. (2017)
Energy consumption	• Lighting systems	Refahi and Talkhabi (2015), Zhao et al. (2016), Zalejska-Johnson (2014), Al-Saadi et al. (2017), Mohamed et al. (2015), Taleb (2014), Shazmin (2021), Chau et al. (2010)

Factors	Sub-factors	Authors
Health	• Lighting • Air Quality	Mendell et al. (2002), Guo et al. (2010), Liu et al. (2019)
Location	• Accessibility	Zrobek et al. (2015), Portnov et al. (2018), Li et al. (2016), Hu et al. (2014)
Environmental Quality	• Cleanliness • Pollution	Hu et al. (2014), Tan and Goh (2018)

4 Methodology

4.1 Data collection

The questionnaire survey is used as an instrument for the primary data collection. The factors that influence occupants to occupy the green residential building was obtained from the literature review, which is affordability, reduces utility bills, location, health, energy consumption and good environmental quality. Therefore, these factors have been used in the questionnaire survey. The questionnaire was distributed using google form online to obtain the highly influential factors that influence occupants to occupy the green residential building. The respondents for this study are the occupants of Molek Pine 4 and Ponderosa Lakeside Apartment. The Likert scale has been used in the questionnaire survey. A calculation has been made and the population of this study are assumed to have 258 in population size. Meanwhile, the sample size representative of the occupants for both green residential building in this study is 72. Meanwhile, the total number of sampling is 75 respondents who answered. It was determined by using the calculation formula by Taro Yamane (1967).

4.2 Data analysis

This research was used a quantitative method. The first objective of this study which is to determine factors that influence occupants to occupy the green residential building was analyzed using content analysis. Meanwhile, the second objective of this study which is to analyze the highly significant factors that influence occupants to occupy the green residential building was analyze using frequency analysis.

4.3 Case study

The case study of this study is at Ponderosa Lakeside and Molek Pine 4 Apartment in Johor Bahru. This apartment is certified as a green building by the Green Building Index (GBI) Malaysia.

5 Results

The first objective that has been carried out from the literature review through content analysis. This is to form questionnaires survey on influential factors that influence occupants to occupy the green residential building. As stated in Table 1, the factors that influence occupants to occupy the green residential building are affordability, reduce utility bills, energy consumption, health, location and good environmental quality. Meanwhile, in order to achieve the second objective of this study, a questionnaire survey has been distributed to the occupants of Molek Pine 4 and Ponderosa Lakeside Apartment. The table below shows the results of this study according to the highest-ranked of influential factors that influence occupants to occupy the green residential by their average mean value.

Table 2 Influential factors to occupy green residential building ranking

Influential Factors	Average Mean Value	Rank
Location	4.32	1
Good Environmental Quality	3.63	2
Health	3.52	3
Energy Consumption	3.51	4
Affordability	3.35	5
Reduce Utility Bills	3.34	6

Based on Table 2 above, it shows an average mean value based on the category of influential factors to occupy the green residential building. The results show that the influential factors for the location were ranked at first place with an average mean value of 4.32. Meanwhile, the second place was ranked by good environmental quality with an average mean of 3.63. Influential factors for health was on the third place of ranked with an average mean value of 3.52. Next for the fourth place was ranked by energy consumption with an average mean value of 3.51. Influential factors for affordability and reduce utility bill with an average mean value of 3.35 and 3.34 were on the fifth and sixth-ranked.

Table 3 Rescale for sub factors of influential factors

Factors	Sub-factors	Mean	Scale
Location	Location are close to the health care facilities	4.44	Very Important
	Location are near to the offices	4.37	Very Important
	Location are near to town of Johor Bahru	4.33	Very Important
	Location are accessible to the main road	4.29	Very Important
	Location are close to the educational facilities	4.19	
Good Environmental Quality	Cleanliness of the apartment	4.03	Important
	Create a good environment quality	3.75	Neutral
	Temperature inside the apartment	3.49	Less Important
	Noises around the apartment	3.25	Not Important
Health	Air quality does not causing difficulties in breathing	3.67	Moderate
	Area surrounding are very clean and comfortable	3.67	Moderate
	Lighting does not causing of sore eyes	3.52	High Dissatisfied
	Lighting does not causing headache	3.51	High Dissatisfied
	The surrounding area does not causing unpleasant smell	3.49	High Dissatisfied
	The layout design does not promote accidents	3.25	High Dissatisfied
Energy Consumption	Lighting system adopt energy efficiency	3.65	Neutral
	Reduce pollutant emission	3.36	Not Important

Factors	Sub-factors	Mean	Scale
Affordability	Affordable price	3.41	Less Important
	Reasonable price range	3.37	Not Important
	Government incentives helps in reducing the price	3.27	Not Important
Reduce Utility Bills	Reduce monthly utility bills	3.57	Less Important
	Less consistency maintenance work on the appliance	3.31	Not Important
	Maintenance savings	3.13	Not Important

To get the scale of the influential factors that influence occupants to occupy the green residential building, index range has been used. In this study, five scale was used for the questionnaire survey. The scale are 'not important', 'less important', 'neutral', 'important', and 'very important'. The maximum and minimum mean value of the influential factors to occupy green residential building are 4.44 and 3.13. Therefore, the index range of the influential factors is 0.262. After the range and average mean value of these influential factors to occupy green residential building has been identified, the influential factors to occupy the green residential building was rescale based on the range of their mean. Table 3 shows the scale of each influential factors to occupy green residential building according to their mean value. Location is the highly important factors to occupy green residential buildings among occupants. In addition, all of the sub-factors for the location were on the highest-ranked and considered as very important factors.

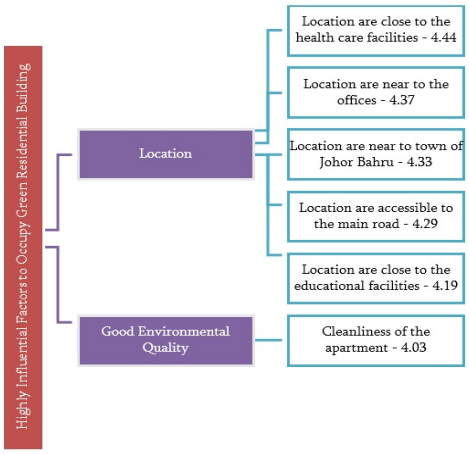

Figure 1 Framework of highly influential factors

Figure 1 above shown a framework of influential factors that influence occupants to occupy the green residential building. The highly significant for influential factors to occupy the green residential building is location. The subcategory of these factors are close to the health care facilities, near to the offices, near to the town of Johor Bahru, accessible to the main road and close to the educational facilities. All of these subcategories have the highest mean value. The second highly significant for influential factors is the good environmental quality which is the cleanliness of the apartment.

6 Discussions

The result for the first objective was achieved which is form the literature review through the past research. Based on literature reviews, factors that influence occupants to occupy the green residential building was identified. The past researchers have been mentioned that factors that influence occupants to occupy the green residential building are affordability, reduce utility bills, energy consumption, health, location, and good environmental quality.

Meanwhile, results for the second objectives in this research have been achieved and analysis has been run through Statistical Package for the Social Science (SPSS). Frequency analysis has been conducted to analyse the data and used to produce the outputs to analyse the highly significant factors that influence occupants to occupy the green residential building. Therefore, the result from this analysis was able to list the highly significant factors to occupy the green residential building.

There are a few recommendations for the government sector from this study. First in an incentive such as tax exemption on interest pair should be given to the home buyers who purchase the green residential building. Next, the government should provide subsidies in some of green products and technologies. Therefore, the cost of the green residential building will be reduced so that the price of the green residential building will reduce. Next recommendation is for the developer. The developer has to develop green residential building tally with the occupant's preferences. Therefore, they can attract more potential buyers to occupy the green residential building.

This research is hindered to a few limitations due to certain circumstances which are unable to study about the component of the green residential building that influences occupants to occupy the green residential building and limit to a small number of sampling respondents due to only cover two green residential building.

There are few suggestions for future research according to the development of green residential building in Malaysia. The suggestions are a study regarding the components of the green residential building that might influence occupants to occupy the green residential building. In addition, a study regarding the affordability of the green residential building. This is because the affordability of the green residential building the price is still considered as expensive. Next is a study regarding the influence factors to occupy the green residential building on behalf of potential buyers.

7 Conclusion

Objectives of this study have been achieved according to the data analysis. The result for the first objectives which are to determine the factors that influence occupants to occupy the green residential building was achieved in from the past research. In addition, the factors derived from the literature review was being used in the questionnaire survey. Meanwhile, the second objectives which are to analyze the highly significant factors that influence occupants to occupy the green residential building also have been achieved using a frequency analysis method.

Based on the result, it can be concluded that the highly significant factors that influence occupants to occupy the green residential building in Molek Pine 4 and Ponderosa Lakeside Apartment are the locations. This was due to the high mean value from overall factors. Location is the key factor that in occupying the residential area. Next ranked was followed by good environmental quality, health, energy consumption, affordability and reduce utility bills. Therefore, the finding in this study showed that even location factor was the main factor in real estate when people choose to occupy their residence, but in the green residential building location factor also is the highly significant factors that influence occupants.

Declaration of competing interest

The authors declare no known competing interests that could have influenced the work reported in this paper.

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