

THE ECOLOGICAL BENEFITS OF ROOFTOP GARDEN FOR THE BETTERMENT OF LOCAL URBAN HABITAT IN MALAYSIA

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Abstract

Rooftop garden is a modification of modern landscape which has the potential to be part of urban greenery system. Therefore, this article attempts to analyse and highlight its environmental benefits which able to solve environmental issues effectively and potential to be part of urban greenery system in Malaysia. An in-depth interview with seven experts in subject matter was conducted to justify the significant impact of this landscape. Based on the findings, all the respondents agreed that rooftop garden can assist city to solve several environmental issues effectively. However, the function and purpose of the landscape should be considered during the design and construction stage so that it can fully attain its objective whether as passive recreational facilities or as for environmental purposes. It is hoped that the research information from this article is useful to encourage its implementation and able to intensify the provision urban green space in Malaysia. Indirectly, it will assist urban area to create a healthy living environment and a balanced between the physical development and preservation of urban green space in the city.

Keywords: rooftop garden, urban greenery system, environmental benefits, sustainable urban development, urban habitat.

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1.0 Introduction

Rooftop garden is a modification of modern landscape that can be part of urban green space in the city. It has the potential to minimize several environmental problems effectively (Tian *et al.*, 2012). Therefore, this article attempts to analyse and highlight the environmental benefit of rooftop garden as part of urban greenery system in Malaysia. It is hoped that the research information from this article is useful to enlighten environmental benefits of rooftop garden to the environment and promote it as part of urban greenery system particularly in Malaysia. Thus, it will assist city to create a healthy environment living and a balanced between the physical development and preservation of urban green space in the city.

2.0 Rooftop Garden In Malaysia: An Overview

Rooftop garden can be defined as a landscape located on the roof, intermediate level or podium deck floor of a multi-storey building (JPBD Semenanjung Malaysia, 2012). Based on Rooftop Garden Planning Guideline issued by JPBD Semenanjung Malaysia, this landscape is not considered as part of 10% of open space provision due to its exclusiveness and can only be utilised by certain group of people (Othman, 2007; Maryanti, 2013). It is also inconsistent with the definition of open space and recreation stated under the Town and

Country Planning Act 1976 (Act 172). According to Section 2(1), open space and recreation is defined as ‘any land whether enclosed or not which is laid out or reserved for laying out wholly or partly as a public garden, park, sports and recreation ground, pleasure ground, walk or as a public place’. Thus, rooftop garden development is only use as a supplementary to the provision of open space in Malaysia particularly for high density city such as in Kuala Lumpur and Penang due to scarcity of land (Mazifah *et al.*, 2014).

Generally, rooftop garden play the same function as open space and recreation on the ground, except the physical location of the landscape that is situated higher than the ground level. Therefore, rooftop garden is also known as ‘sky garden’ because of its high location (Tian dan Jim, 2012). This landscape is designed as a facility for the passive recreational activities such as walking, sitting and viewing. Some of the recreational facilities provided are include bench, children playground, swimming pool, barbeque area, outdoor game facilities and many others. Besides, this landscape are also complete with landscape element such as variety types of flower plants, artificial fountains and also sculptures which meant to provide visual impacts to the occupants.

In terms of use, usually rooftop garden can be enjoyed and utilized by public (Osmundson, 1999). However, in Malaysia it depends on the type of building where rooftop garden is located. If the landscape is placed on residential building, then it can only be utilized by the occupants of the building. This is due to the fact that they have paid maintenance fee to the Management Corporation (MC) which includes the amount to pay the cost of maintaining and managing the landscape on their behalf. Thus, they possess legal right and entitled to fully use of the landscape without any interference from the outsider (Othman, 2007). Otherwise, it is considered as a public amenity if the landscape is intended for public purposes, for example Secret Garden on the roof of 1Utama Shopping Centre. However, rooftop garden in this research is best illustrated in Figure 1 below.



Figure 1: Example of rooftop garden development at Punggol HDB in Singapore
(National Parks Boards Singapore, 2017).

3.0 Rooftop Garden As Part Of Urban Greenery System

Urbanization and development matters often lead to the destruction of urban green areas (Haughton dan Hunter, 2004; Sheng dan Thuzar, 2012). Previous researchers have identified that the percentage of urban green spaces in several cities in Southeast Asia, including Kuala Lumpur has decline along with the growing number of urban population (Noor *et al.*, 2013; Kanniah *et al.*, 2015; Naeem *et al.*, 2016). Ahmad *et al.* (2009) explains that most of urban green areas become smaller and decreasing in size resulting difficulties to the people to do recreational activities or to enjoy nature. Besides the quality of urban environment will also be affected due to the environmental issues occurred particularly urban heat island and air pollution (Wong dan Chen, 2008). In order to overcome these issues, the provision of urban green space especially in high density city that heading towards sustainable urban development should be expanded in a larger context and more diversified (Nor Akmar *et al.*, 2011). The provision of urban green spaces in the city should not be limited to the formation of natural green areas and the provision of open space on the ground (Tian *et al.*, 2012). In contrary, the formation of artificial green system should be considered as a great potential to be applied especially to overcome the issue of land scarcity (Wong dan Chen, 2008). This initiative is to ensure that the provision of urban green space can be provided and able to meet the growing needs of the population (Yuen dan Hien, 2005; Tian dan Jim, 2011; Tian dan Jim, 2012; Tian *et al.*, 2012).

Rooftop garden is some of the examples of building greenery concept that growing rapidly in high density country in the last 10 years such as in Hong Kong and Singapore. Through this concept, the surface of roof can be harnessed and transformed into valuable living space that contributed to the reduction of building impact to the environment such as urban heat island and air pollution, in particular (Givoni, 1991; Wong *et al.*, 2003a; Wong *et al.*, 2003b; Tyrväinen *et al.*, 2005; Wong dan Yu, 2005; Wong dan Chen, 2008; Sapawi, 2009; Sadeghian dan Vardanyan, 2013). Besides, it can improve and add value to the property (Osmundson, 1999). This statement was proven through the research conducted by Tomalty *et al.* (2010) that green roof have positive effect on property value and marketability of nearby real estate. The potential of green roof, rooftop garden as well as rooftop food garden to increase the selling price of a condominium or other type of residential building is proven by the findings. They are:

- i. Properties with accessible green roofs are 11% higher in value;
- ii. Property with rooftop gardens gain 7% in property value;
- iii. Buildings with views onto a green roof could gain up to 4.5% of property value (depending on how many floors have a view of the green roof); and
- iv. Property adjacent to rooftop food gardens could gain from 2% to 7% (depending on distance from the building with the rooftop garden).

Based on the research by Maryanti (2013), rooftop garden is one of the green features that can contribute to Green Building Index (GBI) in Malaysia. This is due to its effectiveness in reducing the impact of urban heat island (Sapawi, 2009), manage storm water runoff (Musa *et al.*, 2008), reduce energy consumption through thermal comfort (Wong *et al.*, 2003a; Wong *et al.*, 2003b) and enhance biodiversity through the preservation of habitat for animals such as birds and insects in urban areas (Brenneisen, 2006). By the provision of rooftop garden, it can assist to maintain green spaces in urban areas that are declining due to the rapid physical development (Chiesura, 2004; JPBD Semenanjung Malaysia, 2012). With sufficient green spaces in urban areas, it will improve the quality of urban environment and the effort towards sustainable urban development can be achieved.

4.0 The Environmental Benefits Of Rooftop Garden

This subsection discussed the environmental benefits of rooftop garden that potentially be achieved through its development in Malaysia. Previous researches particularly from Malaysia and Singapore has proven the effectiveness of rooftop garden in solving several environmental issues in urban area. Since Malaysia and Singapore shared the same climate to plant the same kind of vegetation, thus the contribution of rooftop garden will be equally the same. They are mitigating urban heat island (UHI), managing storm water and saving energy use through maintaining thermal comfort. While, another two benefits was suggested by particular planning guideline in Malaysia, namely preserving habitat for small species of birds and insect's as well as roof garden farming for local food production. The environmental benefit of the landscape are summarized in Table 1 below.

Table 1: The environmental issues in urban area based proven by previous research (Maryanti, 2013)

Researcher	Rooftop garden contributions	Method/Research location
1. Sapawi (2009)	Mitigate urban heat island (UHI)	Experiment on rooftop garden at 1Utama Damansara/Malaysia
2. Musa <i>et al.</i> (2008)	Manage storm water	Experiment on green roof prototype at UTHM/Malaysia
3. Wong <i>et al.</i> (2003a); Wong <i>et al.</i> (2003b)	Save energy through thermal comfort	Experiment on commercial building/Singapore
4. Brenneisen (2006)	Preserving habitat for small birds and insects species	Experiment/Switzerland
5. JPBD Semenanjung Malaysia (2012)		Planning Guideline/Malaysia
6. Hui (2011)	Roof garden farming for local food production	Pilot Study/Hong Kong
7. JPBD Semenanjung Malaysia (2012)		Planning Guideline/Malaysia

4.1 Mitigate Urban Heat Island (UHI) by Sapawi (2009)

Based on the experiment conducted at the rooftop garden 1Utama Shopping Centre, Damansara, the landscape was able to mitigate urban heat island phenomenon and air pollution in the particular area. The shopping centre has a rooftop garden of 30,000 square feet located on the roof of the building. The rooftop garden which also known as Secret Garden have preserved more than 500 species of exotic flora that makes it as the largest rooftop garden in Southeast Asia. Significant difference of temperature can be identified during peak hours from 1pm to 3pm, where the temperature of car park area can reach up to 38°C compared to the roof covered with vegetation which was only 30°C. According to Roslina (2009), the shading effect produced by the vegetation on the roof has significantly reduced the temperature of the building as well as its surrounding area and thus reduces urban heat island effects in the study area.

4.2 Manage Storm water by Musa *et al.* (2008)

An experiment conducted by Musa *et al.* (2008) has demonstrated the effectiveness of green roof in reducing quantity of surface water runoff and managing storm water. They have compared the result of water retention and surface water runoff with the conventional roof using a green roof prototype. The result recorded during few rain events shows that green roof can effectively decrease the surface water runoff compared to conventional roof. This is

caused by grass and soil properties which are able to absorb rain water and less discharge to drainage. Green roof was able to manage storm water 50% better than conventional roof. Indirectly, this technique will assist urban area to avoid from experiencing flash flood during heavy rains.

4.3 Save Energy Use through Thermal Comfort by Wong *et al.* (2003a) and Wong *et al.* (2003b)

Environment will affect and determine how much human will utilize energy to achieve thermal comfort (Heng, 2014). Thermal comfort can be achieved when the temperature of the human body is equal to the temperature of his surrounding (Emmanuel, 2005). If human fail to achieve thermal comfort as they desired, electrical appliances for cooling or heating especially air condition and heater will be used to help them to feel comfortable. According to Wong *et al.* (2003a) and Wong *et al.* (2003b), air condition is one of the main appliances used by offices and homes particularly in tropical climate country in order to feel comfortable in hot temperature. However, it uses high energy, produces greenhouse gases and contributes to global warming. In this case, rooftop garden was proven to save energy use through maintaining thermal comfort of building occupants and minimize the use of air conditioning (Wong *et al.*, 2003a; 2003b) The experiment was carried out at rooftop garden located on top of 5 storey commercial building in Singapore. According to Wong *et al.* (2003a) and Wong *et al.* (2003b), the impact of plant shading can reduce temperature of the building and its surrounding. At the same time, it helps to reduce energy consumption around 25%. In this case, soil depths and plants are important to prevent heat from being transferred to building surface especially during daytime. If compared to bare roof, the heat transfer is very active and faster. Based on the experiment result, the direct effect of vegetation on the roof has contributed to a better outdoor thermal environment. This directly led to the energy saving cause by comfort environment achieved in the building provide by vegetation on the roof.

4.4 Improve Biodiversity Value by JPBD Semenanjung Malaysia (2012) and Brenneisen (2006)

The other ecological benefit resulted from rooftop garden is the property to preserve habitat for birds and small insect as stated JPBD Semenanjung Malaysia (2012). Due to the loss of greeneries in urban area, it has affected the liveability of several species of birds and small insects. Therefore, rooftop garden are able to provide habitat to substitute the losses of urban green space in the city due to rapid development. This landscape can provide basic components of habitat such as protection from weather such as heavy rain, predators, provide food, water and space (Fernandez-Canero and Gonzalez-Redondo, 2010). It has also preserved several plants from being extinct for example a rare species of orchids (Brenneisen, 2006).

Although these examples are taken from other country and there is a difference in terms of climate aspects, however it is still possible that rooftop garden being built in Malaysia can possess the same benefits to improve biodiversity through the preservation of habitat for flora and fauna especially in urban areas. To state a few, rooftop garden at 1Utama shopping centre in Damansara was able to become a temporary habitat for animals such as species of birds, butterflies, grasshoppers as well as habitat for exotic species of flora (Ng, 2016).

4.5 Rooftop Garden for Local Food Production by JPBD Semenanjung Malaysia (2012)

Regardless of its roles as a tool to combat environmental issues in urban area, rooftop garden also served as urban agriculture which encourages the citizen to grow food closer to home. This technique was applied in Hong Kong, Canada, United States, United Kingdom, Japan, Singapore, Thailand, Taiwan and recently blooming in Malaysia (Getter and Rowe, 2006; Hui and Chan, 2011). In 2008, the Ministry of Agriculture and Agro-Based Industry has introduced Program Bumi Hijau (Green Earth Program) as a measure to encourage the people to provide their own food supply. According to the ministry, the roof of a building can be transformed into private agriculture area to carry out farming activities to plant vegetables and local fruits. It is believed that urban agriculture is a new efficiency concept for sustainable and liveable city (Hui and Chan, 2011). Even though there are some constraints and limitation issues that may arise such as lack of available land and suitable space, land use control and building regulations, microclimate conditions, and urban lifestyle, the benefit of urban agriculture is still tremendously important to assist food chain and supply in the city (Hui and Chan, 2011).

5.0 Research Methodology

This article is attempted to convince the ecological benefits of rooftop garden for betterment of local urban habitat in Malaysia from the view of experts in related field. Thus, a qualitative research design has been applied to recognise the environmental benefit of rooftop garden and its contributions as part of urban greenery system in Malaysia.



Figure 2 : Rooftop garden at case study building (Maryanti, 2013).

As illustrated in Figure 2, a certified green building (residential) with rooftop and herbs garden was selected as case study. Five environmental benefits namely mitigating urban heat island, energy saving through thermal comfort, managing storm water, preserving habitat for small animal and rooftop garden farming for local food production were identified to be very significant to the case study in terms of its contribution to Green Building Index (GBI) assessment under Sustainable Site Management (SM) and Innovation (IN) criteria. Therefore, these environmental benefits of rooftop garden were selected to be validated by the experts on how these ecological benefits of rooftop garden can assist for the betterment of local urban habitat in Malaysia.

Seven respondents were selected using purposive sampling method. The identification of these respondents has been made through external desk research to obtained relevant information about the respondents. Subsequently, appointment was set up with each of the respondents to conduct face to face interview using semi-structured interview form. Except one of the respondents from Singapore that uses email interview. All the respondents involved in this study are described in Table 1 below.

Table 1: Respondents description.

Respondent (Code)	Organisation	Job Position/ experience	Meeting Location	Eligibility
A1	Department of Building, School of design and Environment, National University Singapore, Singapore	NUS Professor / 14 years	Email interview	Published many relevant research articles in journals regarding rooftop garden in Singapore
A2	Institute of Sultan Iskandar (ISI) of Urban Habitat and High Rise, Universiti Teknologi Malaysia, Skudai.	UTM Professor and GBI Facilitator / 21 years	Respondent's Office at ISI	His experience in various fields including sustainable development, architecture, building performance and public park design.
A3	Malaysia Green Building Confederation (MGBC), Kuala Lumpur	Board of Directors and GBI Facilitator / 8 years	Respondent's Office at MGBC	Assessing building for green certification of GBI
A4	JPBD Negeri Selangor, Bangunan Darul Ehsan, Shah Alam	Planner / 8 years	Respondent's Office at Bangunan Darul Ehsan	Planning Selangor towards sustainable development
A5	Sustainable Development Unit, Majlis Perbandaran Petaling Jaya (MBPJ), Selangor	Deputy Director of Planning Department, MBPJ / 20 years	Respondent's Office at MBPJ	Planning Petaling Jaya towards sustainable development
A6	Kumpulan Arkitek Sdn. Bhd.	Architect / 6 years	Respondent's Office at Wangsa Maju	Green building design
A7	Property developer TSI Domain Sdn. Bhd., Kuala Lumpur	Property manager / 15 years	Respondent's Office at Kuala Lumpur.	Managing property with rooftop garden

The data gathered from the interview were analysed using thematic analysis and quotation to describe the respondent's views and perspectives regarding the ecological benefits of rooftop garden for the betterment of local urban habitat in Malaysia.

6.0 Result And Discussion

Based on the discussion of the broad review of literature in the previous section, many researchers such as Jim (2004); Wong dan Chen (2008); Tian dan Jim (2012) and several other researchers has acknowledged the importance of rooftop garden to enhance

urban green space provision particularly in high density urban area. Wong dan Chen (2008) stressed that optimum planting around building will assist the city towards sustainable urban development. The lack of vegetation in urban area will only cause the city to face many environmental issues especially urban heat island which will impact on the liveability of the city and the well-being of the people (Hui, 2011).

Based on the interviews, respondent A1, A2 and A3 were agree that rooftop garden play an important role towards sustainable urban development in Malaysia. They stated that even though green building applied environmental friendly building design but the landscape around the building should not be neglected.

‘The significance impact of the roof garden not only enhances the aesthetic value of the site, but it can also improve air quality and provide excellent shading effect to the surrounding area of the building’ (Respondent A1).

‘By integrating the elements of building and outdoor landscape, the surrounding environment of the building will be more healthier where the air quality can be improved, the city atmosphere is more shady while the city look more attractive. Therefore, the integration between the design of sustainable building and innovative landscape outside the building should be given further attention and consideration’ (Respondent A2).

‘Urban green space preservation strategies are not necessarily to be modern as long as they can have a positive impact on the environment. Roof garden is one of the strategies that have long been used in overseas. Today, it has become an effective technique in reducing the impact of the construction industry to the environment, especially the urban heat island. Indirectly, this technique will support the national agenda towards sustainable urban development’ (Respondent A3).

In Malaysia, there are several states has encouraged the development of rooftop garden as one of the strategies to support national agenda towards sustainable development, among them are include Selangor. According to Respondent A4:

‘The increased number of population has led to the need for new areas to provide more housing, public utilities, commercial infrastructure and so on. The absence of clear urban development limits will create urban sprawl which causes development to spread into sensitive areas, major agricultural land, and other areas that are unsuitable for development. Hence, here is the role of landscapes such as roof garden, pockets park, courtyard or green walls to balance the rapid development of the city, conserving the environment and green areas that have been affected by urban development’ (Respondent A4).

The respondent agrees that rooftop garden is one of the techniques towards sustainable urban development. Based on its positive impact as emphasised in this study, rooftop garden should be integrated into urban development in Malaysia; not only on residential building but also expanded to non-residential buildings especially office, commercial and industrial building that use extensive air conditioning during the day.

Besides, MBPJ also has stated in its Special Area Plan (SAP) for Seksyen 13, Petaling Jaya to promote shady environment by creating green landscape around the building through the provision of indoor and outdoor landscape such as rooftop garden, courtyard and

others. The plan was adopted to provide Seksyen 13 in Petaling Jaya as a commercial park that is attractive and conducive to live, work and play. In this plan, rooftop garden is functioned as a recreational area and attractive landscape for residential and office building. In addition, it also serves as a landscape for the environmental purposes. Besides the SAP, MBPJ also encourage the developers to create rooftop garden on their residential building project. Developers will be given incentives in terms of higher plot ratio as to motivate them to support the Selangor agenda towards sustainable development and at the same time, gaining higher profit.

In terms of sustainable building design, Respondent A6 agreed that landscape is one of the important components in the green building design as both concept (green building and outdoor landscape) will assist to combat global warming contributed by mass conventional building industry.

‘By providing green landscape around green building, it not just beautify the surrounding area but also become one of the techniques to give positive impact to the environment’ (Respondent A6).

Based on the case study, Respondents A7 stated that,

‘Principally, the provision of rooftop garden in this housing scheme is planned to be utilised as a facility for the building occupants to do passive recreational activities. However, the GBI assessment for green building certification under Residential New Construction (RNC) category shows that the rooftop garden has contribute in terms of reducing the temperature between units with rooftop garden compared to other unit that located far from the landscape or at the higher level. Even though the difference of temperature is not so significant, but it can be considered as an effective techniques if some of the improvements as recommended by GBI are executed’ (Respondent A7).

The statement was proven by the GBI assessment for green building certification under Residential New Construction (RNC) category for the case study showing that the rooftop garden as well as herbs garden has contributes marks under Sustainable Site Management (SM) and Innovation (IN) criteria as described in Table 2 below.

Table 2: Description of GBI assessment for case study under GBI Tool for Residential New Construction (RNC)

Criteria Code	Description	Marks
SM4	Open space, landscape and urban heat island i. Mitigating urban heat island phenomenon; ii. Improve biodiversity.	4/37
IN1	Innovative design and environmental design initiative i. Herbs garden	1/6

Based on information from the table, it is show that rooftop garden contribute 5 marks out of 43 marks allocated under SM4 and IN1 criteria. However, Respondent A3 stressed out that the significant contribution of herbs garden at the case study as rooftop garden farming for local food production can contribute higher marks in GBI assessment under RNC or NRNC (Non-Residential New Construction) if the herbs garden area cover at least 10% or 20 meter square from the whole landscape area (whichever is higher). Respondent A3 further explained that the contribution of rooftop garden for the betterment of local urban habitat in Malaysia is very much depending on its performance to mitigate

environmental issues. Therefore, Respondent A1 recommend to determine the purpose and function of rooftop garden during the design stage whether the landscape will be used solely for the purpose of recreational facilities or environmental or both. Once the function has been determined, only then it will contribute to its highest and best use.

In this case, the design stage of rooftop garden development is vital to prepare the landscape for its purpose. Respondent A1 has emphasised the use of several type of suitable vegetation to be planted on the roof as well as the depths of the soil to achieve thermal comfort and hence, saving the energy. Based on the research conducted by Respondent A1 in Wong *et al.* (2003b), the energy saving was estimated 3% less than the overall annual energy consumption of the commercial building. Therefore, if the design stage is to be put into a careful consideration, the building owner or the occupants will enjoy higher percentage in energy saving and less figure in their electrical bills.

7.0 Conclusion

Based on perspectives of the respondents, it can be concluded that the ecological benefits of this landscape such as mitigating urban heat island (UHI), managing storm water, saving energy usage through maintaining thermal comfort, preserving habitat for small species of animal particularly birds and insects as well as for the purpose of local food production through rooftop farming are significant for the betterment of local urban habitat in Malaysia. The contribution of rooftop garden is almost equal to the benefits provided by urban green space on the ground. Thus, it should be given further attention and consideration to be part of urban greenery system in Malaysia, especially for high density city to overcome the issue of land scarcity.

However, in Malaysia rooftop garden is not a major leap towards sustainable urban development. Rooftop garden is simply use to add value or selling point to the property (Maryanti, 2013). On the other hand, the provision of rooftop garden as part of open space has been prevented due to the legal provision under Town and Country Planning Act 1976 (Act 172), under Section 2(1), whereby JPBD Semenanjung Malaysia (2012) has clearly stated that rooftop garden cannot be defined as open space, thus it is not bound to the 10% provision of open space in every development scheme to obtained Planning Permission. As the result, rooftop garden is only seen as a passive recreational facility that provides minor benefit in terms of visual impact to the occupant as well as a supplementary to the provision of open space on the ground. Four respondents (Respondent A1, A2, A5 and A6) has shared the same opinion that several development constraints in terms of high cost to develop and maintain has become the major barriers of its implementation (Ismail *et al.*, 2012). Besides, lack of planning policy and incentives provided by the government to encourage the implementation of rooftop garden followed by the lack of awareness among the society has also restraint its expansion.

In this case, several authors such as Nor Akmar *et al.* (2011) argued that the definition of open space as stated in Section 2(1), Act 172 should be expanded in a larger context and more diversified to encourage its implementation among the PBT and developers, hence allowing and assisting those city to increase their urban green space provision due to the issues of land scarcity. Mazifah *et al.* (2014) also agreed that the insufficiency or inadequacy of urban green space provision on the ground due to the scarcity of land has led several PBT to accept the provision of rooftop garden as an alternative to provide adequate green space for the people. Therefore, the appropriate incentives and planning policy is required to motivate developer to implement this landscape in their property development and hence contribute for further betterment of local urban habitat in Malaysia in the future in

terms of a healthy environment living and a balanced between the physical development and preservation of urban green space in the city.

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