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Cultural Practices Generated by Structural Biodiversity of Two Urban Forests in Johor Bahru, Malaysia

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ABSTRACT

The use of urban green space is a determinant for urban inhabitant's well-being. However, increasing urbanisation lessened the opportunity for urban inhabitants to engage with green space. This situation requires landscape planners to design an urban green space with maximum benefits that fulfil inhabitants' needs for their well-being. Structural biodiversity is an essential element in generating the benefits and values interpreted through the activities at the urban green space. This paper aims to identify the cultural practices that influenced by structural biodiversity of two urban forests in Johor Bahru, Malaysia. Multiple Response Analysis was used to analyse the data from on-site questionnaire surveys completed by 253 visitors of both urban forests. The result shows that a high-density urban forest offers an opportunity for visitors to get attached to nature and attract visitors to involve in sedentary and moderate activities. In contrast, a moderate density urban forest offers a less natural value that attracts visitors to take part in moderate and vigorous activities with less engagement with nature. This study would contribute to a better understanding of the structural biodiversity that influenced visitors' cultural practices, where the present condition of the two urban forests has illustrated the current benefits that visitors obtained from the ecosystem.

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1. Introduction

Maintaining the well-being of urban inhabitant is a critical aspect of ensuring the quality of life. Currently, most of the developed countries, including Malaysia, are having rapid development because of the increasing population that lives in the urban area. Malaysia Department of Statistics (2019) stated that there are 32.4 million populations in Malaysia until the year 2018, and 75.45% from the populations lived in the urban area. Increasing the rate of urbanisation have a significant impact on green spaces (Aida *et al.*, 2016; Kabisch *et al.*, 2015) where the number decreases while the demands for green spaces increase in line with the increasing number of population. Availability of green spaces in an urban area is the platform for inhabitants to improve their physical and mental well-being (Karuppannan *et al.*, 2014; Schipperijn *et al.*, 2013; Schipperijn *et al.*, 2010). Besides supplying spaces for physical activity, urban green space plays a vital role in providing habitat for wildlife (Haaland & van den Bosch, 2015) which provides an opportunity for inhabitants to engage with nature (O'Brien et al., 2017). In a rapid development area, the spatial pattern of green space is influencing the way inhabitants perceived and used the place. Whether inhabitants using the green space with maximum benefits or they using it because they have no other places for their physical activity.

The central element that shapes the way inhabitants perceived and used green space is structural biodiversity which defined as the composition and configuration of biotic entities (Lausch et al., 2016). Voigt *et al*. (2014) have included the diversity of biotic features, abiotic site conditions and infrastructure of urban parks in measuring inhabitants' evaluation and activities. Biotic features are the only dimensions considered in this study because of the dominant factors that affect the ecosystem components and functions of green space (Giergiczny *et al*., 2015; Harrison *et al*., 2014; Van Renterghem, 2018). The composition and configuration of biotic features have shaped the spaces for inhabitants (Foo, 2016; Gunnarsson *et al*., 2017) and habitat for wildlife in green space (Jasmani *et al*., 2016; Mexia *et al*., 2018). These factors are related to spatial elements and spatial patterns that are affecting the functions of the green space and influencing inhabitants' movement and activities. A beneficial green space does not depend only on the size of the place but needs to consider benefits that inhabitants get from their visits (de la Barrera *et al*., 2016; Xu *et al*., 2016). It is how landscape planners play their roles in planning and designing the structural biodiversity of green space.

This study adapted from the cascade model (Haines-Young & Potschin, 2010; Potschin-Young *et al*., 2016; Small *et al*., 2017; Spangenberg *et al*., 2014). Cascade model is a framework that links the process in an ecosystem which starts from the organisation of elements in the ecosystem until the benefits that people get from the ecosystem. There are two main components in the model; supply and demand (Wei et al., 2017). The component of supply factors is a biophysical type that includes the structure and functions of an ecosystem which influences green spaces to provides ecosystem services to users. The component of demand factors is a beneficiary type which correlated to the supply factors. The organisation of ecosystem elements is crucial steps in the model that reflects the function of green spaces. It is about measuring the performance of green space in providing services that fulfil inhabitants demand while using the place. The model shows the capacity of a green space ecosystem in providing benefits to the inhabitants, and also to the wildlife of the greenery that becomes one of the main contributors to deliver the benefits.

Ecosystem services is a transition process in the cascade model that specifies whether a green space supplies the services that match the needs that inhabitants' demands. It connects the structural biodiversity of an ecosystem with the functions that give benefits to inhabitants (Andersson-Sköld et al., 2018; Potschin-Young et al., 2016). Millennium Ecosystem Assessment, MEA (2005) define ES as benefits that people obtain from ecosystems. Four types of ES commonly involved in this field: provisioning services, regulating services, supporting services and cultural services (MEA, 2005). Currently, ES research trend focused on cultural ecosystem services (CES) due to the lack of study on the services, especially in the urban area (La Rosa *et al*., 2016). CES describes as an intangible or non-material ES (Xiao *et al*., 2017) that challenging to measure because of the direct benefits offered to inhabitants that engage with green space which is subjective and influenced by inhabitants' onsite experience (Ko & Son, 2018; Stålhammar & Pedersen, 2017). It is a people-place and human-ecosystem relationship that directly affects inhabitants' well-being includes stress relief and health promotion, especially for urban inhabitants that have limited choice for green space (Ko & Son, 2018). As urbanisation continuously increased, the quality of urban green space is a vital role in ensuring CES to meet the increasing demand from urban inhabitants due to decreasing in the quantity of green space.

In the model, it shows that the balance achieved between supply and demand factors have enabled the use of CES. However, Fish et al. (2016) highlighted that various CES emerged from a series of cultural practices. In line with this, various frequent activities at urban green spaces shape the categories of cultural practices based on the engagement between people with each other and the natural world. Table 1 shows the operational definition of all categories of cultural practices. The cultural practices that visitor undertakes which in relation to the structural biodiversity of urban green spaces is a determinant for the benefits and values that they obtained from the place (O'Brien *et al*., 2017). Fish *et al*. (2016) have relate the formation of cultural practices with the places, localities and landscape of an ecosystem, which shaped the identities, experiences and capabilities of the green spaces that allow the cultural practices to happen. The consideration of the structural biodiversity and cultural practices are mutually reinforcing the formation of CES to fulfil inhabitants' demand for urban green spaces (refer Figure 1).

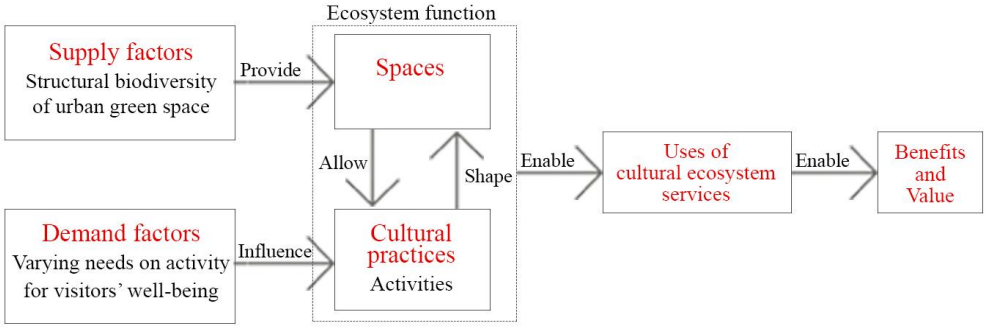

Figure 1 Key aspects include cultural practices, in cascade model of a green space

Table 1 The operational definition of categories of cultural practices according to Church *et al.* (2014) framework

Cultural practices: Activities that relate people to each other and the natural world.		
Categories of cultural practices	**Definition**	**Examples**
Playing and exercising	Activities of non-work leisure time involving informal and physical interactions between people and the natural environment	Walking, jogging, cycling, sitting, viewing, listening, picnicking and paddling
Creating and expressing	Activities of non-work leisure time defined by the conscious construction of symbolic artefacts and processes	Drawing, painting, photography, writing, and poetry
Producing and caring	Activities that blur the distinction between labour and non-labour engagements with the natural environment	Cultivating land for food production, fishing, gardening environmental volunteering, and citizen science
Gathering and consuming	Activities spanning passive and active engagements with the natural world and which occur in both work and non-work contexts	Consuming food and drink of local provenance, collecting wild food, fibre and ornaments and consuming non-conversational media and genre about a place (e.g. local art/artefacts/popular media/performances)

Although the study on the field of cultural ecosystem services increases, yet there is still a lack of study on the structural biodiversity of the accessed green space that influences cultural practices derived from the place. Since the cultural practices are a new component in the model (Church et al., 2014), current studies on cultural ecosystem services that related to physical elements of green space are mostly not considered cultural practices. Some examples of the current studies are visitors' perception (eg. Riechers et al., 2018; Bertram and Rehdanz, 2015), mapping cultural ecosystem services (eg. Clemente et al., 2019; Brown et al., 2018; Soy et al., 2018) and green spaces components that influence the services (eg. Ridding et al., 2018; Belmeziti et al., 2018; Palliwoda et al., 2017). Therefore, this paper aims to identify the cultural practices of urban inhabitants that influenced by structural biodiversity of urban green space. Which cultural practices are the most happening in the urban green space? How the structural biodiversity of urban green space affect the cultural practices of the place? The aim will support the cascade model in discovering cultural ecosystem services of green space which shaped through inhabitants' various frequent activities.

2. Methods

2.1 Study Area

The unit of analysis for this study is urban inhabitants that use urban green space for their well-being. Urban forest was selected as a study area because it offers a variety of spaces that provides all type of structural biodiversity. This study was conducted at two urban forests located at the second-largest city in Malaysia, which is Johor Bahru. The city is a rapidly urbanised area that increasingly populated until this period. The increasing rate of development in Johor Bahru every year leads to the current number of population which is above 1.5 million inhabitants (Pelan Pertumbuhan Strategik Johor, 2019) and 0.8 from the numbers are live in the city (World Population Review, 2019). This scenario shows the high percentage of urbanisation occurs, which requires a more substantial area for development that causes decreasing in the greenery of the city area. The two urban forests are Majlis Bandaraya Johor Bahru Urban Forest (MBJBUF) and Majlis Bandaraya Iskandar Puteri (MBIPUF). Both vary significantly in the surrounding landscape and therefore provide different structural biodiversity. These two urban forests are open to the public, attached to heavy vehicle road and have differences in terms of site context, stand age and the density of vegetation. Table 2 shows the criteria of each urban forest. The differences between urban forest give different impact to visitors because the different criteria and percentage of vegetation cover might influence the impact that inhabitants get when access to the place (Mexia et al., 2018). Figure 2 shows the situatedness of the urban forest located in the south of Malaysia and near to Singapore, which is one of the reasons why the rate of urbanisation of the district is rapidly increasing.

2.2 Data Collection

2.2.1 Site Survey on Structural Biodiversity

The independent variables for this study consist of biotic features that contribute to forming an ecosystem and providing cultural ecosystem services to visitors. In the context of this study, the data collected consist of the land cover of the urban forest that was parallel to the function offered to the urban inhabitants. A site survey was conducted through an observation using unmanned aerial vehicles, UAVs (Park & Ewing, 2017). The data gathered from UAV observation were able to identify the current configuration of vegetation at the urban forest, as shown in Figure 3. The data includes the spatial aspect of a landscape such as spaces, vegetation density, canopy cover and site context. The step was followed by the on-the-ground observation that able to identify in detail the presence of each element. The percentage of the land cover was analysed and quantified using i-Tree Canopy application from i-Tree Eco v5 modeling tool (www.itreetools.org). A 1000 sampling point was plotted in the application that involved with five elements, which were tree canopy cover, field, lake, facilities and other surfaces. The elements of other surfaces include pedestrian walkway and jogging track. Figure 4 and Figure 5 demonstrates the percentage of the land cover for both urban forests.

Table 2 The criteria of MBJBUF and MBIPUF

Criteria	Urban Forest	
	MBJB	**MBIP**
Location	Located approximately 1.5 km from the city centre, Johor Bahru	Situated at Mutiara Rini, a township in Skudai, one of well-developed Johor Bahru district.
Site context	Government centre, educational centre, residential area and graveyard	Residential area, and commercial centre
Stand age	31 years	10 years
Vegetation density	High density because it was covered by 76.86% vegetation of the used area	Medium density because it was covered by 57.9% vegetation of the used area

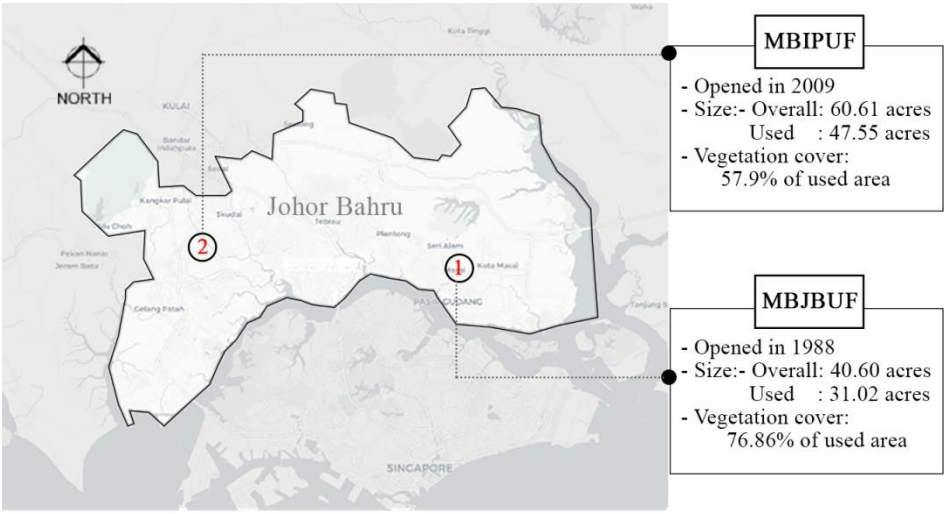

Figure 2 Location of the two study areas in Johor Bahru; (1) MBJBUF and (2) MBIPUF

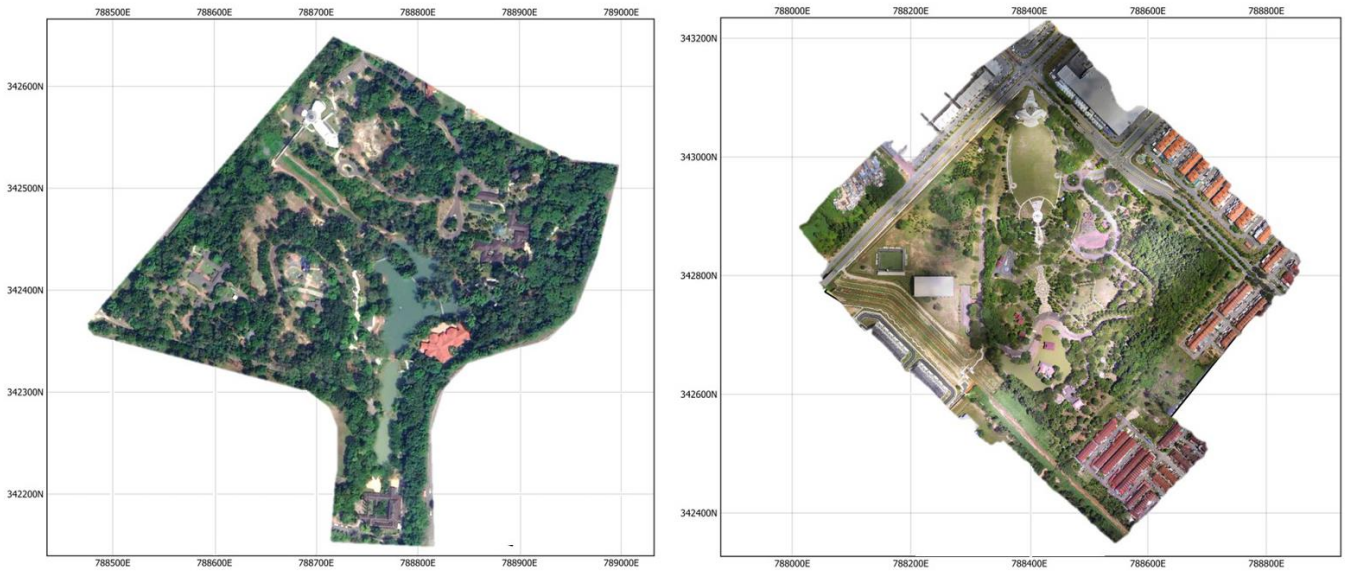

Figure 3 Aerial photos of MBJBUF (left) and MBIPUF (right)

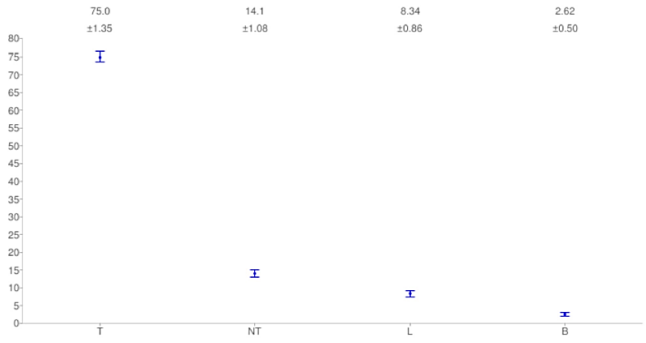

Figure 4 The percentage (+/- SE) of land cover at MBJBUF [T: Tree canopy cover; NT: All other surfaces; L: Lake and B: All facilities provided]

The data in Figure 2 and Figure 3 illustrates that MBJBUF is a natural-like area that provides mature trees with diverse tree species and dense canopy cover (50-70% canopy closure). This is corresponding to Figure 4 that shows 75% of MBJBUF consists of tree canopy cover. Besides the children's play area, the primary area of the urban forest that highly utilised by visitors was the spaces around the lake. The area has a high percentage of tree species diversity, a group of big trees and diverse water edge. The least used was the area that not well maintained, although it has a high percentage of vegetation cover. The percentage of the land cover indicates that MBJBUF has a high complexity of tree canopy density which gives continuous shade to the visitors.

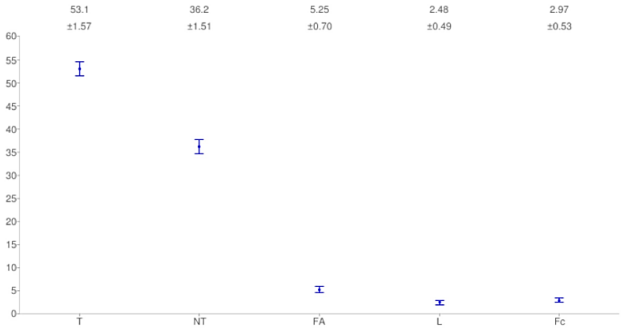

Figure 5 The percentage (+/- SE) of land cover at MBIPUF [T: Tree canopy cover; NT: All other surfaces; FA: Field area; L: Lake and F: All facilities provided]

In contrast, Figure 3 shows that MBIPUF provides medium vegetation density with medium canopy cover (30-50% canopy closure) that offers less shade to the urban forest. In sum, MBIPUF has a high density of large woody vegetation area, playground area, field, a group of small tree, open spaces, tree-lined path and lake area. As shown in Figure 5, the most dominant is tree canopy cover (53.1%), followed by all other surfaces (36.2%), field area (5.25%), facilities (2.97%) and lake (2.48%). The most utilised area was open canopy spaces around the lake and field, followed by the walking or jogging route that lined with a row of trees. All of the areas in MBIPUF were used, but not all visitors attracted to access to the dense-wooded area at the east side of the urban forest.

Data in Figure 4 and Figure 5 reveals significant differences of the land cover between MBJBUF and MBIPUF. Almost all spaces of MBJBUF were covered by dense tree canopy, whereas only half of MBIPUF stands with dense canopy cover. The difference of the land cover is the main contribution of the structural biodiversity in an ecosystem in shaping cultural practices for visitors' well-being. In line with Irvine and Herrett (2018), difference structure of an ecosystem may provide difference opportunity and need for socio-ecological interaction that highlight the delivery of multiple cultural ecosystem services to the visitor.

2.2.2 On-site Survey Questionnaire

The first phase of this stage is a semi-structured face-to-face interview to identify the dependent variable of this study which is the frequent activity of visitors when visiting the urban forest. This phase was also created to identify the most common words used in describing the activities. Based on the gathered results, the authors have revised back the questionnaire that was designed for the actual data collection.

It was a multiple-choice question that allowed visitors to choose more than one activity in the answer list because this study was to investigate the most frequent activity at the urban forest. The actual data collection was involved with the distribution of survey questionnaires. It was conducted within two months during the weekend and weekdays. Two hundred and fifty-three questionnaires were completed by the visitors which were randomly approached at different areas of the two urban forests. The respondents included all of the visitors in the age between 15 years and above, with the diversity of ethnicities, occupations and levels of education. One hundred and thirty-six respondents completed the questionnaires at MBJBUF and the rest by visitors at MBIPUF. The numbers of respondent were adequate to represent the total population of urban inhabitants that use the urban forest in two months. The minimum sample size was identified using the equation by L.Grande (2016) as shown below, with 95% of confidence level and 0.045 margin of error.

$$\text{Sample size} = \frac{\frac{Z^2 \cdot p(1-p)}{e^2}}{1 + \left(\frac{Z^2 \cdot p(1-p)}{e^2 N}\right)}$$

2.3 Data Analysis

IBM SPSS Statistics 24 was the data editor used to compute all of the data from the survey questionnaires. The question involved in this study was designed to investigate the frequency of activities done in both urban forests. Multiple Response Analysis was used to analyses the differences of cultural practices at MBJBUF and MBIPUF based on the frequency of visitors' activities.

3. Result and Discussion

3.1 Structural Biodiversity and Cultural Practice of a Mature High Density Urban Forest

Figure 6 reveals the frequent activities that visitors do when visiting the two urban forests. The frequent activities in MBJBUF were walking (14.3%), enjoying nature and greenery (13.8%), sitting (12.6%), spending time with family (11.5%), and jogging (11.2%). The result shows that the mature and high density urban forest has provided natural-like surrounding that attracted visitors to enjoy nature and leisure activities of the setting. MBJBUF with high biodiversity purposes has given variety ambience of dense greenery that increased the attractiveness of the urban forest (Giergiczny et al., 2015). According to Wang *et al.* (2019), an increasing number of trees was enhancing visitors' aesthetic preferences. This is corresponding to the structural biodiversity of MBJBUF, which provided complex and rich greenery that increased the aesthetic value of the study site. In line with the study by Wang *et al*. (2017), the structural biodiversity of MBJBUF has motivated visitors through the high level of vegetation where sedentary and moderate activities were preferred over the vigorous activities.

Additionally, in conjunction with the study by Guo *et al*. (2017), the urban forest with a high density of vegetation was able to attract wildlife because of the light penetration, multiple resources of food and sufficient open spaces to forage. This type of structural biodiversity has widened the ecological corridors for wildlife and birds to move without interference from the visitors. The dense vegetation cover of MBJBUF as shown in Figure 3 has also provided enough shades for visitors and shelter for the wildlife and birds. The interrelationship of the natural value offered by the urban forest has brought relaxation and serenity to the visitors that they rarely get from a densely built-up urban area (Sandifer, Sutton-Grier, & Ward, 2015). This situation was parallel to the four activities at MBJBUF that have a higher frequency than MBIPUF, which were enjoying nature and greenery, wildlife and birds viewing, picnicking and spent time alone. The result highlighted that the structural biodiversity of MBJBUF has shaped the cultural practices of the urban forest, which promoted the opportunity for urban inhabitants to be close to nature. Furthermore, the dense vegetation cover has influenced visitors' activities to be dependent on shaded spaces, seating possibilities, as well as the feeling of solitude.

However, some activities were less frequently happened at MBJBUF such as picnicking (5.2%), playing sports (4.3%) and cycling (1.8%). The data in Figure 4 illustrates that the urban forest only has 14.1% of spaces that accessible for activities. Although the larger space of tree canopy cover has provided better engagement between visitors and nature, this kind of environment has lessened the spaces for the activities that involved with the specific social group. This reflects the low frequency of social activities due to the limited space, which decreased the opportunity for interaction between visitors. Identical to Moulay *et al.* (2017), the relationship between the size and function of spaces in a large urban green space need to associate with each other in order to fulfil visitors' needs on the activities that require specific space. The configuration of dense tree canopy cover also plays a vital role as it offered various environments that influenced visitors' satisfaction towards services that they get from MBJBUF. Instead of the size and function of the space, the dense structural biodiversity has reduced the spaces allocated for all activities. This situation has minimised the privacy and comfort for the activities of the specific social group. The result demonstrated that MBJBUF has no specific functional spaces for picnicking, playing sports and cycling, which weakened visitors' dependency on MBJBUF for that purposes.

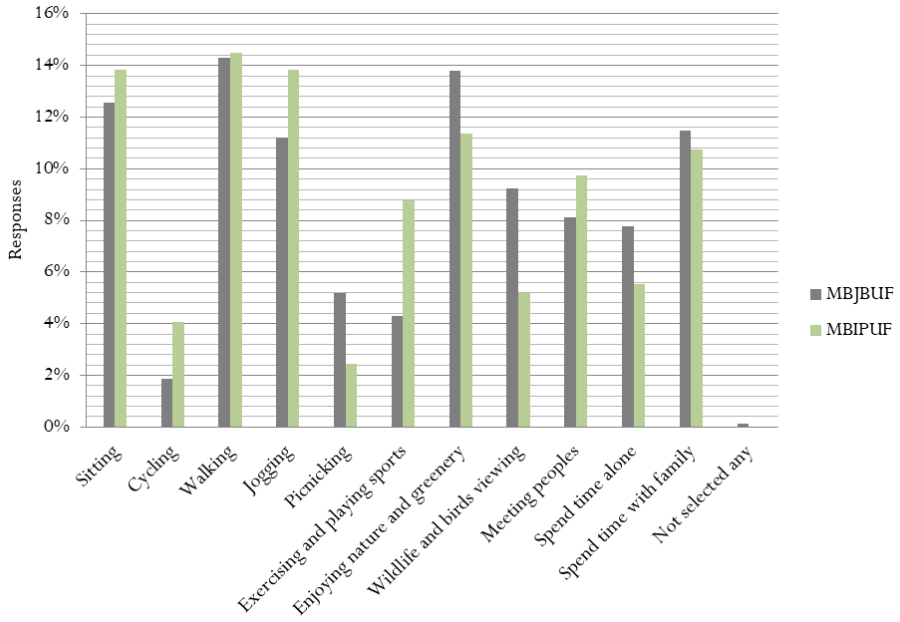

Figure 6 Result from Multiple Response Analysis on the frequent activities at the two urban forests

3.2 Structural Biodiversity and Cultural Practice of a Moderate Age with Medium Density Urban Forest

In contrast, the most frequent activities at MBIPUF were walking (14.6%), jogging (14.0%), sitting (14.0%), enjoying nature and greenery (11.5%), and spending time with family (10.8%). The result shows that the medium density urban forest with medium canopy covers (30-50% canopy closure) has provided a surrounding that encouraged visitors to enjoy the moderate, vigorous and sedentary activities more than they enjoyed the nature. The most frequent activities at MBIPUF were slightly different from MBJBUF, where jogging was among the highly ranked activity. Although MBIPUF has a space of the dense-wooded area, it was not commonly used by the visitors because of poorly maintained. The wild and messy surrounding of the area has given a negative valuation on the services offered by the dense-wooded area (Muratet, Pellegrini, Dufour, Arrif, & Chiron, 2015). The structural biodiversity of MBIPUF was spatially spreads and forms a medium level of biodiversity that consists of more open spaces and medium canopy stands with various heights of vegetation. The visitors' engagements with the nature of MBIPUF were lower because most of the visitors' activities were concentrated at a well-managed area that has medium canopy covers. This was in line with the studies by Gunnarsson *et al*. (2017), where the area that offered less density of structural biodiversity has decreased the natural value of the urban forest which also impacted the attractions of the greenery among visitors.

Equally important, the open and semi-open spatial design of the structural biodiversity of MBIPUF has provided the opportunity for visitors to involve in vigorous activities. As illustrated in Figure 6, there are three significant differences of activities at MBIPUF that have a higher frequency than MBJBUF. The activities were playing sports, jogging and cycling. The result was in consistent with Rey Gozalo *et al.* (2019), where a larger size of the urban forest was matters in influencing visitors' vigorous activities. The size of MBIPUF, 60.61 acres, was reasonable to provide a greater length of route and adequate spaces for that type of activities. The tree-lined paths along the provided route were connecting the open spaces with the spaces of medium canopy covers. The continuous structural biodiversity of MBIPUF was provided greenery that maintained the biological diversity of the medium density urban forest that contributed to the well-being of visitors. This situation shows that despite having vast open spaces for vigorous activities, the medium density vegetation cover was still provided a comfortable environment for visitors, such as shade effect and aesthetic attraction from the medium greenery (Adinolfi, Suárez-Cáceres, & Cariñanos, 2014).

Besides, the least frequent activities at MBIPUF were wildlife and birds watching (5.3%), cycling (4.1%) and picnicking (2.5%). The result was corresponding to the structural biodiversity of the area that used to be accessed most by the visitors. Identical to Palliwoda *et al.* (2017), the structural biodiversity of MBIPUF was reflected the lower activity of wildlife and birds watching as the environment has minimised the key factors needed by the creatures. In fact, in spite of having continuous canopy covers for wildlife and birds' travel routes and diverse height of vegetation for their sources of food, the medium canopy covers was surrounded by open spaces that lessen the size, protection and microclimate of wildlife and birds' habitat which reduced their biodiversity level at the urban forest (Bahari, Said, & Rusli, 2018). The result also demonstrated that the urban forest was not preferred by visitors for the activities of cycling and picnicking. The main reason was because of the wide-open spaces provided by MBIPUF were exposed to the hot and humid weather of Malaysia that lowered the relaxation and serenity environment for the activities (Sreetheran, 2017). In the same vein of MBJBUF, the less frequent activity of picnicking and cycling at the urban forest shows that these two activities were not the primary intention for visitors in Johor Bahru to visit an urban forest.

4. Conclusion

This study reveals the primary category of cultural practice shaped by both urban forests in Johor Bahru, which is 'playing and exercising'. The existing structural biodiversity is influencing the activities that visitors undertake based on the condition of spaces that they engage in the urban forest. Specifically, the size and functions of a space have a significant relationship with the structural biodiversity that build aesthetic appeal, privacy and comfort of the space. Urban forest with a dense canopy cover is providing a better opportunity for urban inhabitants to get closer to nature, while medium canopy cover that has wide open spaces is supplying convenience spaces for vigorous activity. However, some specific limitations must be taken into consideration. This study only focuses on how the existing structural biodiversity of urban forest was influencing the cultural practices of urban inhabitants. These aspects are essential for landscape planners in enhancing or maintaining the existing urban green space to optimise the quality of spaces in order to offer maximum benefits for urban inhabitants' well-being. It is crucial to consider on the correlation between different elements of structural biodiversity and urban inhabitants' demand for urban green space for future research. In this respect, despite the opportunity provided for playing and exercising, the identification of the impacts of specific structural biodiversity elements on urban inhabitants' demand may result in investigating other categories of cultural practices needed by the inhabitants.

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