



UNIVERSITI PUTRA MALAYSIA

**EFFECTS OF LANDSCAPE ENVIRONMENTAL SETTINGS ON
MICROCLIMATE IN ENHANCING PEDESTRIAN WALKING DISTANCE IN
TROPICAL CAMPUS ENVIRONMENT**

ZANARIAH BINTI KASIM

FRSB 2019 13



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By

ZANARIAH BINTI KASIM

**Thesis Submitted to the School of Graduate Studies, Universiti
Putra Malaysia in Fulfilment of the Requirements of the Degree of
Doctor Philosophy**

June 2019

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DEDICATION

In the Name of Allah swt., I dedicated this work to:

Those who love peace

Those who believe that we can make a better future

And

*Those who have special place in my heart: my beloved husband, my mother
(Hajjah Kelesom Biniti Dolah), children & family*

*Thank you very much for all your love, sacrifice and patience.
Indeed, we belong to Allah and indeed to Him we will return.*

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in
fulfilment of the requirement for the Degree of Doctor Philosophy

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ZANARIAH KASIM

June 2019

Chair: Mohd Fairuz Shahidan, PhD
Faculty: Design and Architecture

Design is one of the primary elements in conceptualizing campus conducive for learning. One of the criteria that define such as a campus is the promotion of greens, open spaces and walkways. Walkways are important as it helps to create a conducive and healthy campus. An environment with comfortable walkways tends to entice walking. Walking contributes to health and a sustainable way of transportation around campus. Nevertheless, a tropical climate has high ambient air temperatures and relative humidity year-round making walking uncomfortable and unpopular. A suitable microclimate can provide thermal ameliorating effects on pedestrians. However, how it affects pedestrian walking distance and the landscape environmental settings have not been adequately investigated. A good knowledge on campus microclimates becomes important in sustainable campus planning and design. Therefore, this research investigated pedestrians' thermal comfort and comfortable walking distances for different landscape settings in a tropical campus pedestrian environment. It observes and measures pedestrian thermal comfort and walking distance based principally on the physical properties of the landscape settings and the surrounding environment.

The research posited four research questions. Data collection was divided into three parts. First, an observation method was used to identify the various types of landscape environmental setting in tropical campuses. Four Malaysian higher learning campuses were selected to evaluate the existing conditions of the pedestrian environment according to the Landscape Environmental Settings for Pedestrians (LESP). This led to the proposed five types of LESP (Type 1, Type 2, Type 3, Type 4, and Type 5). The second and third part of data collections were carried out in Universiti Putra Malaysia (UPM) campus in

Serdang, Selangor. In the second part microclimatic field measurements involving five microclimatic parameters (Air temperature (T_a), globe temperature (T_g), surface temperature (T_s), wind velocity (v), and relative humidity (Rh) were collected for all the types of LESP. These were then ranked according to pedestrian comfort. The third part involved field surveys and measurements. The field survey was conducted in UPM campus at the five types of LESP sites concurrently with field measurements of the five microclimatic parameters.

Results revealed that different types of LESP provide different thermal comforts. The findings also indicated that it is important to modify the solar radiation in a walkway environment by having a continuous shade. This could be provided by either trees alone or trees together with man-made shade structures along the walkway. The study also found evidences that the impact of LESP on comfortable walking distance in a tropical environment is related to pedestrians' thermal comfort. The more LESP influences pedestrians' thermal comfort, the longer will be the comfortable walking distance. LESP with full shades from two rows of trees can provide a 1.0 km comfortable walking distance. Thus, it can be concluded that LESP influence microclimates in enhancing pedestrian thermal comfort of tropical environments. Therefore, LESP that are conducive for walking should be provided in tropical campuses to encourage walking. The findings provide new knowledge for landscape architects and urban planners in specifying appropriate microclimatic interventions to improve pedestrian comfort in tropical environments.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

**KESAN SUASANA PERSEKITARAN LANDSKAP KEPADA IKLIM MIKRO
DALAM MENINGKATKAN KESELESAAN JARAK BERJALAN DALAM
PERSEKITARAN KAMPUS TROPIKA**

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Reka bentuk adalah salah satu unsur utama dalam membentuk konsep kampus yang kondusif untuk pembelajaran. Salah satu kriteria yang menentukan kampus sebegini ialah pengalakan kawasan hijau, ruang terbuka dan laluan pejalan kaki. Lorong pejalan kaki penting kerana ia membantu mewujudkan kampus kondusif dan sihat. Persekitaran berlaluan pejalan kaki selesa akan mengalakkan berjalan kaki. Berjalan kaki menyumbang kepada kesihatan dan pengangkutan lestari dalam kampus. Walau bagaimanapun iklim tropika bersuhu udara dan berkelembapan relatif tinggi sepanjang tahun membuatkan berjalan kaki tidak selesa dan tidak popular. Iklim mikro yang sesuai boleh memberikan kesan pengurangan terma kepada pejalan kaki. Walau bagaimanapun kesan iklim mikro dan bagaimana ianya mempengaruhi jarak berjalan kaki dan juga sifat landskap dipersekitarannya belum diselidiki secukupnya.

Oleh itu pengetahuan yang sesuai mengenai iklim mikro kampus menjadi penting dalam perancangan dan reka bentuk kampus lestari. Kajian ini dilakukan bagi meneliti keselesaan terma dan jarak berjalan kaki yang selesa bagi pejalan kaki untuk persekitaran landskap yang berbeza dalam persekitaran pejalan kaki kampus tropika. Ia meninjau dan mengukur keselesaan terma dan jarak berjalan pejalan kaki berdasarkan pada sifat fizikal landskap dan persekitarannya.

Penyelidikan ini mengutarakan empat soalan penyelidikan. Pengumpulan data dibahagikan kepada tiga bahagian. Pertama, kaedah tinjauan digunakan untuk mengenal pasti pelbagai jenis persekitaran landskap sedia ada di kampus tropika. Empat kampus institut pendidikan tinggi Malaysia telah dipilih untuk

menilai keadaan sedia ada persekitaran pejalan kaki berasaskan Suasana Persekitaran Landskap Pejalan Kaki (LESP). Ini menghasilkan lima jenis LESP cadangan (Jenis 1, Jenis 2, Jenis 3, Jenis 4, dan Jenis 5). Bahagian kedua dan ketiga pengumpulan data dijalankan di kampus Universiti Putra Malaysia (UPM), Serdang, Selangor. Bahagian kedua pengumpulan data melibatkan pengukuran medan lima parameter iklim mikro (suhu udara (T_a), suhu glob (T_g), suhu permukaan (T_s), halaju angin (v), dan kelembapan relatif (R_h) untuk semua jenis LESP. Analisis dan susunan kedudukan data adalah mengikut tahap keselesaan pejalan kaki. Bahagian ketiga melibatkan tinjauan dan pengukuran lapangan. Kajian lapangan serentak dengan pengukuran lapangan 5 parameter iklim mikro dibuat di kampus UPM meliputi 5 jenis tapak LESP berkenaan.

Keputusan kajian menunjukkan bahawa jenis LESP yang berbeza akan menghasilkan keselesaan terma yang berbeza. Penemuan ini juga menunjukkan bahawa penting untuk mengubah radiasi matahari dalam persekitaran jalan kaki dengan mengadakan naungan berterusan. Ini boleh dibuat sama ada dengan naungan pokok semata-mata ataupun pokok-beserta struktur buatan manusia di sepanjang lorong jalan kaki. Kajian itu juga membuktikan bahawa kesan LESP pada jarak berjalan yang selesa dalam persekitaran tropika berkaitan dengan keselesaan terma pejalan kaki. Semakin kuat LESP mempengaruhi keselesaan terma pejalan kaki, semakin jauh jarak selesa berjalan kaki. LESP dengan naungan penuh daripada dua baris pokok dapat menyediakan 1.0 km jarak berjalan yang selesa. Dapatlah disimpulkan bahawa LESP mempengaruhi iklim mikro dalam meningkatkan keselesaan terma pejalan kaki di persekitaran tropika. LESP yang kondusif untuk berjalan kaki harus disediakan dalam kampus kawasan tropika untuk mendorong berjalan kaki. Penemuan kajian ini menawarkan pengetahuan baharu untuk arkitek landskap dan perancang bandar dalam menentukan intervensi iklim mikro yang sesuai untuk meningkatkan keselesaan pejalan kaki dalam persekitaran tropika.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

LESP	Landscape Environmental Settings for Pedestrian
T_a	Air temperature
T_g	Globe temperature
T_s	Surface temperature
v	Wind velocity
Rh	Relative humidity
Tc	Thermal comfort
Tr	Thermal rate
Wc	Walking comfort
Wd	Comfortable walking distance



CHAPTER 1

INTRODUCTION

1.1 Introduction

Campus design is one of the primary elements in conceptualizing campuses for teaching and learning. There are a number of criteria that define a conducive campus design (Shuhana et al., 2007). One of the key elements is the promotion of greens, open spaces and walkways. Walkways are important as it helps to create a healthy campus (Lau, Gou, & Liu, 2014). An environment with creative and comfortable walkways tends to entice the campus community to walk that extra mile.

However, promoting 'walking' among the campus community is not an easy task especially in countries with a hot and humid climate like Malaysia (Asadi-shekari, Moeinaddini, & Shah, 2014). Promoting walking will reduce the dependency on motorized vehicles, which in turn reduces the use of fossil fuels and the emission of greenhouse gas (GHG). The latter has led to global warming and climate change (Borrego et al., 2018; Lee et al., 2016).

Heat and the polluted environment lead to pedestrian discomfort. In other words, if the weather is hot and the air is humid, it is very unlikely that a pedestrian is going to enjoy walking. Thus, pedestrian comfort is the pleasant feeling that people feel when they interact with the environment (Zakaria and Ujang, 2015). The subset of pedestrian comfort is pedestrian thermal comfort. This is agreed by many (Capri et al., 2016; Hwang, Lum, & Chan, 2015; Lin, Matzarakis, & Hwang, 2010; Shashua-Bar, Tsiros, & Hoffman, 2012; Villadiego & Velay-Dabat, 2014) as one of the demotivating factors for either for short distance or long distance walking. Walking is the most basic mode of getting from one point to another and it is the most convenient way for staffs and students to move around campus. Nevertheless, in order to encourage them to walk, the campus-built environment has to provide a safe and comfortable walkway (Cepolina, Menichini, & Gonzalez, 2018).

A campus landscape environment is crucial in measuring the sustainability of any campuses (Matloob et al., 2014). This is evident when half of the criteria in UI GreenMetric ranking (Suwartha & Fitri, 2013; "UI GreenMetric," 2016) are related to this matter. The sixth criteria are i) setting and infrastructure, ii) energy and climate change, iii) waste, iv) water, v) transportation, and vi) education. The criteria of setting and infrastructure, energy and climate change and transportation are related to the campus landscape environment. The

metric shows that those criteria affect the sustainability of a campus. A good campus must have high scores in all the criteria. Figure 1.1 shows that Universiti Putra Malaysia (UPM) is not 100% sustainable especially in the area of energy & climate change as well as transportation.

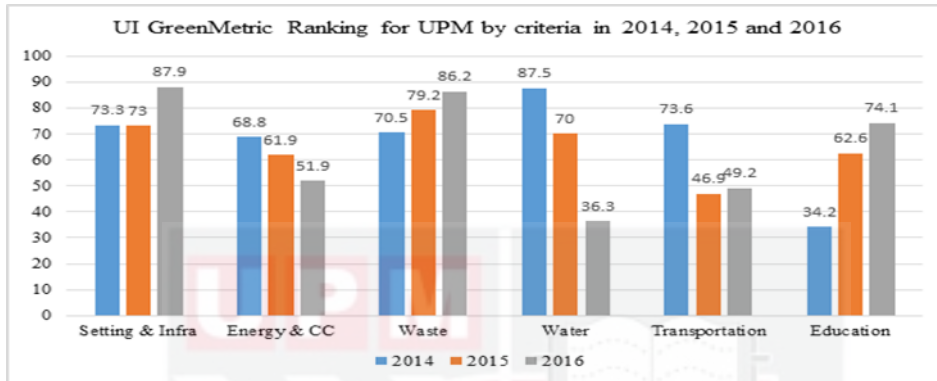


Figure 1.1: UI GreenMetric Ranking: UPM
(source: UI GreenMetric 2016)

In fact, the criterion for energy & climate change recorded a decreased from 68% in 2014 to slightly above 50% in 2016. Similarly, the percentage for transportation has recorded a remarkable decrease of 23% from 2014 to 2016 (“UI GreenMetric,” 2016).

Transportation remains as one of the crucial factors in connecting the various parts of the campus. A university campus can be likened to a small city which has areas of businesses, residential, recreation, and also transportation system (Saadatian, Sopian, & Salleh, 2013). Thus, it shares similar problems as a city such as noise pollutions, traffic congestions, increase in use of motorized vehicles and other environmental problems. One of the effects of urbanization in a city is the increased dependency on privately-owned vehicles. A similar trend also occurs on Malaysian university campuses (Norzalwi and Amiruddin, 2011). Malaysian Transport Department statistics shows the number of vehicles in Malaysia has increased from 2010 to 2015. Another study reveals a link between national and campus statistics. This study was carried out on the main campus of the International Islamic University of Malaysia and it reported that the number of registered privately-owned vehicles on campus increases by 1.8% annually (Rahim, 2013).

However, this increase in the volume of vehicles on campuses is not supported by the campus infrastructure. A study by Abd-Razak et al. (2011) found that the transportation system in Malaysian campuses is dominated by the circulation of vehicles. The circulation system is not user friendly especially

in cases where pedestrian walkways and roads are not separated. The scenario worsens when the campus is not properly planned.

There are two types of campus planning in Malaysia: the well-planned campus and unstructured campus planning (Abd-Razak et al., 2011). Private universities normally have a well-planned campus, and this usually set a good example of how campus life should be (Shuhana et al., 2007). On the other hand, unstructured planning campuses are the most common type in Malaysia. Malaysia's public universities such as Universiti Malaya and Universiti Putra Malaysia fall into this category (Abd-Razak et al., 2011). These universities were first established as schools of a certain discipline before evolving into a university. Universiti Putra Malaysia is a case in point where it began as a small School of Agriculture in 1931 before it develops into the current comprehensive university (UPM, 2017).

In addition, the increase in the dependency on privately-owned vehicles by students have contributed to the pressure on the limited roads and related infrastructure especially parking spaces in residential and academic areas (Azmi and Karim 2012b). Privately-owned vehicle dependency causes traffic congestions, not to mention a requirement for large tracks of land for parking. The green areas on these campuses will have to be converted for roads and parking spaces resulting in less natural areas on campus. In addition, the air quality will deteriorate and affecting the health of the campus community.

Students need restorative and stress-reducing environments. This means more greening and natural elements in the campus environment. There are evidences showing that a campus environment with plenty of trees and other natural elements can integrate the campus community and consequently improves students' academic achievement (Matsuoka, 2010).

This study attempted to evaluate the landscape environmental settings of pedestrian walkways that relate to the pedestrians' thermal comfort and comfortable walking distance in tropical campus environment. It is believed that the different landscape environmental setting will contribute to different thermal comforts and walking distances (Kasim, Shahidan, & Yusof, 2018). The increase in comfort will in turn increase the comfortable walking distance. The study aims to increase pedestrians' thermal comfort and comfortable walking distance through/within different landscape environmental settings in tropical pedestrian environment.

1.2 Problem Statement

The tropical climate is characterized by high ambient air temperatures and relative humidity year round; a diurnal maximum temperature of 31°C to 34°C

and a minimum of 23°C to 26°C (Hwang et al., 2015). On top of this, temperature has been rising in urban areas, with an observed increase of 0.25°C per decade since 1970 (Hwang et al., 2015). Urban areas in Malaysia, Singapore and other tropical cities also experience the urban heat island (UHI) effect because of its urban development (Benrazavi et al., 2016; Shahidan, 2011). The heavy use of air conditioning throughout the cities to mitigate high temperatures, not only increases energy consumption, but worsen the UHI effect (Al-Masrani et al., 2018; Girgis, Elariane, & Razik, 2016). Facing such conditions, many countries have conducted studies in a bid to manage the urban heat at the macro level (Qin, 2015; Taleghani, 2018a). Differences in temperatures measured on sites and by official weather stations highlight the insufficiency of relying on general regional measurements taken by fixed weather stations (Ahmed et al., 2016) and the need to calibrate the value of the urban temperature (Hirashima, Assis, & Nikolopoulou, 2016). It is suggested that local micro-scale thermal measurements are used to verify the thermal experience of outdoor users in such places as parks, squares and campus grounds (Gaspari, Fabbri, & Lucchi, 2018; Piselli et al., 2018). Thus, there is a need to measure the pedestrian microclimatic environment that influences walking comfort of outdoor users.

A green campus environment can also encourage the campus community to prefer walking. Walking plays a fundamental role in the sustainability of a place and it has a lots of benefits to the campus community (Cubukcu, 2013). Walking helps in improving social surveillance and social integration among the campus community. It can also create a sense of place and connects people to nature. Most importantly, walking will improve quality of life and health of those on campus (Merican, 2018). In walkable campuses, students and staffs walk to destinations such as from their dormitories to classes, library, administration buildings and public transportation points. Indirectly, this helps to reduce vehicles gas emissions (Balsas, 2003).

However, walking is not yet a popular choice on Malaysian campuses as found in a study by Azmi and Karim (2012b). The study found only 22% of the respondents chose to walk. The distance between buildings in Malaysian campuses tend to be far apart and it also reveals a lack of consideration on pedestrian comfort. In a hot humid climate, outdoor comfort is the most challenging factor for planners and designers to deal with. And this may contribute to why walking is not preferable amongst campus community in Malaysia. A study on thermal comfort at the International Islamic University of Malaysia, Kuala Lumpur suggested that different sites produced different microclimates (Bakar and Gadi, 2016). It also found that solar radiation plays an important role in influencing the thermal environment of an area/space. The study indicates that the thermal environment for the open area is hotter than the semi-shaded area and the latter is hotter than the covered area. Therefore, it is important to evaluate these pedestrian's needs of comfort and the types of landscape environmental settings that can provide comfort to walkers.

In a tropical climate, pedestrians are often exposed to high thermal loads, which can cause thermal discomfort and even heat-stroke. Makaremi et al. (2012), found that only 23% of the students surveyed felt comfortable in an evaluation of thermal comfort conditions of shaded outdoor spaces in Malaysia's hot and humid climate. In a study by Shahidan, et al. (2012), suggested that suitable conditions can be obtained through proper treatments of these environments. This in turn encourage walking, improve urban microclimate and reduce energy consumption.

Shading, either from tree or man-made structures in landscape environmental setting for pedestrians is crucial for their thermal comfort (Benrazavi et al., 2016; Huang et al., 2018). It can prevent from solar radiation, which the most important factor for discomfort in tropical climate. Cases of heat stroke have been reported in Malaysia. For instance, there were 14 cases of heat-related illnesses from March 1 to 18 March in 2016 (Shahar, 2016). In April 2016, Malaysia reported two death due to heat (Mail, 2016).

Thus, the issue of heat ties in with the need to provide shades for walking. Hwang et al. (2015), for instance, demonstrated that the value of shade is critical to the thermal points in Singapore urban parks. The focus of this study is, thus, to evaluate the effects of landscape environment settings on microclimates in enhancing pedestrian thermal comfort in tropical campus.

Hypothetically, shades encourage pedestrians to walk more as it provides thermal comfort for walking. There are many studies on walking distance involving urban and neighbourhood areas (Gunn et al., 2017; Guo & Loo, 2013; Manaugh & El-geneidy, 2013). However, studies looking at the campus context is limited. Furthermore, these studies have shown different result for walkable distances. Azmi and Karim (2012a), suggested that the comfortable walking distance in Malaysian neighbourhoods is 200 meters. People will choose to drive if the distance is more than 200 meters and walking comfort decreases depending on unsuitable microclimate environments lacking in trees.

Therefore, measuring pedestrian thermal comfort is important in order to understand how outdoor thermal comfort relates to walkable distance environment and also surrounding environment (Fang et al., 2019). Thus, this study will also measure the comfortable walking distances based on pedestrian landscape environment settings in various landscape scenarios of tropical campus environment.

1.3 Research Questions

In accordance with the study background, the research questions are:

1. What landscape environmental setting characteristics influence pedestrians' thermal comfort in a tropical campus environment?
2. How does landscape environmental setting influence microclimate and pedestrians' thermal comfort?
3. How does landscape environmental setting condition in various landscape settings affect pedestrians' thermal comfort and comfortable walking distance?
4. What are the landscape design criteria for pedestrians' thermal comfort and comfortable walking distances in a tropical campus environment?

1.4 Research Aim and Research Objectives

The aim of this study is to investigate pedestrians' thermal comfort and comfortable walking distances for different landscape settings in a tropical campus. The study observed and measured pedestrian thermal comfort and walking distances based principally on the physical properties of the landscape settings and the surrounding environment. This study highlighted the tropical campus environment by using as a case study of pedestrian walkways with different landscape environment settings.

The following objectives are formulated to achieve the study aim:

1. To investigate existing campus environmental characteristics influencing pedestrians' thermal comfort.
2. To measure the influence of landscape environmental settings on microclimate and pedestrians' thermal comfort.
3. To evaluate the relationship between pedestrians' thermal comfort and comfortable walking distances in various landscape settings.
4. To propose a landscape design guideline based on the measured pedestrians' thermal comfort and comfortable walking distances for tropical campus environments.

1.5 Research Hypotheses

1. Variations in landscape environmental setting characteristics can create a different influence on the microclimate in tropical campus environment.
2. Pedestrian' thermal comfort is influenced by the landscape environmental settings.
3. Variations in landscape environmental setting characteristic can create a different effect on pedestrians' thermal comfort and comfortable walking distance.
4. Walking comfort distances increase when pedestrian's thermal index decreases because there is relationship between comfortable walking distance and pedestrian's thermal comfort.

1.6 Research Scope and Limitations

This research focused on the various types of landscape environmental settings on pedestrian thermal comfort and comfortable walking distance in Universiti Putra Malaysia. As the focus of the study is microclimate of landscape environment setting of pedestrian walkways, this investigation does not include pedestrian walkways within buildings. This allows for better understanding of outdoor landscape elements and their impacts on pedestrians' thermal comfort. Therefore, the investigations focus on the influence of cooling impact on pedestrian thermal comfort and the comfortable walking distance in outdoor environment of a tropical campus.

The field measurements to investigate pedestrian thermal comfort and survey perception on thermal comfort and walking distance are conducted in five different days at the same time (12:00 to 15:00) in five various types of site. Due to time, cost and equipment limitations the field measurements and surveys are conducted in one type of LESP a day at the same time each day. However, this has not contributed to much influence on the study results as the tropical weather condition is relatively consistent throughout the year. Similarly, this study also did not include the anthropogenic effects of vehicles due to its relatively small number in city centre and negligible in residential and commercial areas (Jamei et al., 2016). Therefore, it was assumed that the anthropogenic effects from vehicles did not influence the results of this study. The study also did not include data from a weather station because this study measured the actual microclimate in the study area and is not static at a particular point. Therefore, the absence of weather station is assumed not having any implication on the results.

The analyses were conducted in three parts which describes the scope and limitation of the study: (a) Landscape Environmental Settings for Pedestrian (LESP); (b) Microclimate field measurement in LESP types; and (c) Pedestrian thermal comfort and comfortable walking distances.

1.7 Significance of the Study

This study contributes to Landscape Architecture, Urban Design and other related fields in terms of new knowledge as well as enhancing practice in the following manner:

- a) Contributions to knowledge in Landscape Architecture, Urban Design and other related fields.

Firstly, within Landscape Architecture and Urban Design, there has been no previous study focusing on the effects of landscape environmental settings towards microclimate for pedestrians' thermal comfort in tropical environments. Previous research on pedestrians' thermal comfort were focusing on evaluating climatology of urban square, open spaces, street canyon and space between buildings (Jamei & Rajagopalan, 2017; Niu et al., 2015; Salata et al., 2016a; Yang, Lin, & Li, 2018; Yang et al., 2013). However, there is a gap of knowledge on the linkage between pedestrians' thermal comfort and comfortable walking distances in these tropical environments. This has not been adequately explored while the potential effects of Landscape Environmental Settings for Pedestrian (LESP) have been duly overlooked. Therefore, there is a need to evaluate the relationship between pedestrians' thermal comfort and comfortable walking distance in various landscape environmental settings of tropical environments. This study can be a basis for future studies by researchers investigating other aspects of this issue.

Thus, the study contributes to the growing body of literature on LESP, categories of LESP and the systematic measures of comfortable walking distance based on their pedestrian microclimate in tropical climates. It will be an extension of knowledge on outdoor thermal comfort of pedestrians in LESP types and their characteristics.

- b) Contributions to practice in Landscape Architecture, Urban Design and other related fields.

Firstly, the study is important in creating awareness of the importance of LESP in enhancing pedestrians' thermal comfort and thus promoting walking in a tropical walkway environment. Study on LESP can enhance the role of

landscape elements as a sustainable catalyst of a campus or urban area through their physical characteristics.

Secondly, the study is important in inspiring campus walkability and healthy lifestyle. Without proper understanding on the significance of the pedestrian walkway to the users and factors influencing pedestrian comfort, the walkway will fail to provide a comfortable environment for walking. More importantly, a good pedestrian walkway can encourage people to walk if certain guidelines are followed in the design and construction. The aim is to avoid depending on privately-owned motor vehicles on campuses.

1.8 Research Framework

Study on pedestrian thermal comfort requires exploring theories and specifying the knowledge of landscape environmental setting attributes that influence pedestrians' thermal comfort supported by literature review. The first study objective is to investigate the characteristics of existing campus environments influencing pedestrians' comfort and thermal environment while the second objective is to evaluate the relationship between pedestrians' thermal comfort and the identified environmental settings.

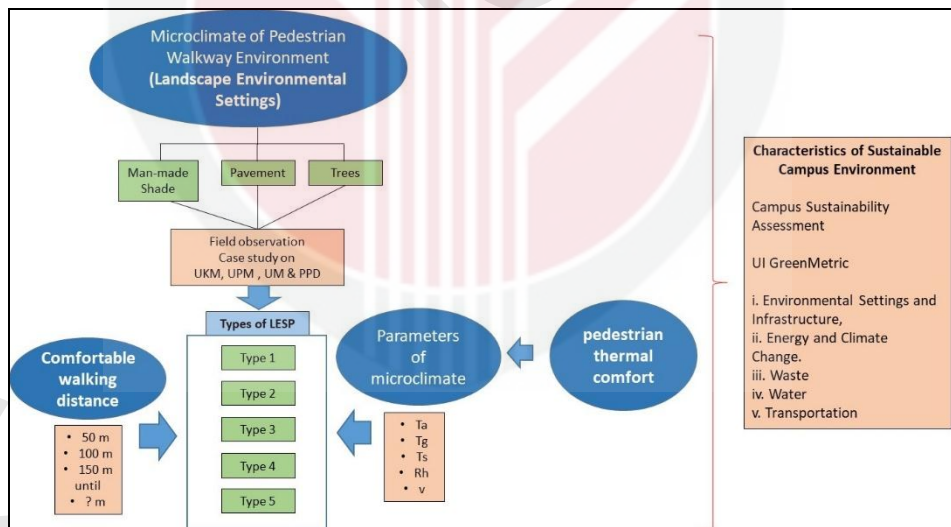


Figure 1.2 : Research Framework of the Study

The study measures the effects of landscape environmental settings on walking environment considering the influences of landscape elements such as trees, pavements, and man-made shades.

Three Malaysian university campuses (UKM, UM and UPM) and a polytechnic campus (Politeknik Port Dickson - PPD) have been chosen for the observation. These campuses are chosen because they represent established campuses in Malaysia (Abd-Razak et al., 2011). The observation is to identify the various types of landscape environmental settings in tropical campuses. This study will measure five parameters of microclimate: Air temperature (T_a), Globe temperature (T_g), Surface temperature (T_s), Wind velocity (v), and Relative humidity (Rh). The other measurement is Comfortable walking distance (Wd) based on the theories of walking distance. These two categories of measurements were conducted in the five different types of landscape environmental settings for pedestrian (LESP).

1.9 Summary of the Chapter

This chapter highlights the needs of this study to improve the pedestrian's walkways environment to enhance walkability in tropical campuses. It describes the issues related to the need for this study, its problem statement, and research framework. Focus was given to the microclimate of pedestrian environment that influences walking comfort of outdoor users in order to further understand of the current scenario.

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- Kasim, Z., & Muda, R. (2013). The criteria for sustainable polytechnic campus in Malaysia. In ARDENAS 2013. Politeknik Malaysia.
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