

# EVALUATION OF THE COST IMPLICATION ON PUBLIC PARK MAINTENANCE



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## **ABSTRACT**

### **Para1 - Intro**

Landscape maintenance is an art keeping the landscape healthy, clean, safe and attractive when we speak about parks or gardens. For public open space, the process of maintenance is somewhat more complicated considering the vast landscape areas, the limitations of funds and even the political aspirations of the local authority. The style and intensity of maintenance have a much more significant effect on the cost of upkeep than the organisation or efficiency of carrying it out. In general terms, the detail or complexity of a site's layout influences its maintenance cost, apart from the type of landscape and its degree of formality.

### **Para2 - Research significant**

In Malaysia, A vast amount of money has been spent on developing urban parks, including the facilities; thousands and even millions of Ringgits have been spent yearly by the local authorities to maintain our public park. However, there are still countless parks and open spaces that have been built with excellent facilities for the public but are being unkempt, deteriorating into disrepair and poorly maintained. Are all these issues further connected to the maintenance cost implication factor? Hence, considering the importance of the public park to the community and how this is a critical link to landscape maintenance, there is a need for a cost-efficiency study that can set forth a strategy that best works to mitigate this issue.

### **Para3 - Methodology**

Adopting a mixed-methodology approach, this research first established a checklist of maintenance standard procedures via Literature Investigations to verify it by acknowledged professionals of the field. The verified checklist assists in developing the basis and context for Semi-structured Interviews with elected professionals and practitioners. The gathered data

were analysed in establishing the themes, parameters and attributes for cost-effective maintenance.

#### **Para4 – Expert Validation on the Criteria of Sustainable Landscape Maintenance**

The expert validation findings toward the sustainable landscape maintenance checklist focus on the parameters for sustainable landscape maintenance. The Percentage of Consensus of Agreement (PoCoA) analysis applied for this section has further demonstrated the significance of landscape maintenance parameters acknowledged by the experts. The summary of these findings have wrap up the expert's validation process for Phase 1 assessment and conclusion.

#### **Para5 – Analysis of Landscape Maintenance Towards Cost Implication**

The phase two analysis that expanded from phase one findings further highlight issues related to the current landscape maintenance practice that links to its operational cost. In-depth discussion related to cost efficiency associated with effective operational maintenance further evidence six components that link effective maintenance with cost efficiency: getting a reliable maintenance contractor, detailed scope of work in maintenance contract, knowledge competency, recycling the landscape waste, consistency of landscape maintenance program, and modern technology. To expedite maintenance work, new technology through modern maintenance tools and equipment and appropriate modern machinery can support maintenance activities.

#### **Para6 – Conclusion and Recommendations**

It can be concluded that the current maintenance procedure is indeed ineffective and costly. Therefore, this research proposes sustainable landscape maintenance criteria for a more cost-effective and sustainable maintenance approach. Future research directions that expand this research offer another dimension of venturing into landscape waste management and sustainable landscape design focus.

## ACKNOWLEDGEMENT

We would like to express our unfathomable appreciation and gratitude to the Institute of Landscape Architects Malaysia (ILAM) for the opportunity to participate in this research exercise and for awarding us the research grants, which definitely lessen the financial burden, thus making the completion of this research possible.

We wish to extend our appreciation to all professionals who have helped us during the running of the pilot survey. Our utmost gratefulness and appreciation to all interviewees for consenting and participating in the Semi-structured Interviews during data collection sessions. We are forever indebted by your contribution in the form of experiences, knowledge, tips and pointers, and most of all, your precious time. We are also obliged to our employer, the Universiti Teknologi MARA, Perak Branch, for the permission, encouragement and support to our research.

This research task is a short study of the broad domain of urban park maintenance and its cost implications. Hence, we wish to emphasise that the research outcome is at the exploratory stage, and a more comprehensive study is needed for a more pivotal and definite conclusion. Be that as it may, we believe that the outcome is still significant and able to contribute significantly to the industry, policymakers, practitioners and contractors.

Above all, we owe it all to Allah SWT, the Almighty God, for granting us the wisdom, health and strength to undertake this research task and enabling us to its completion.

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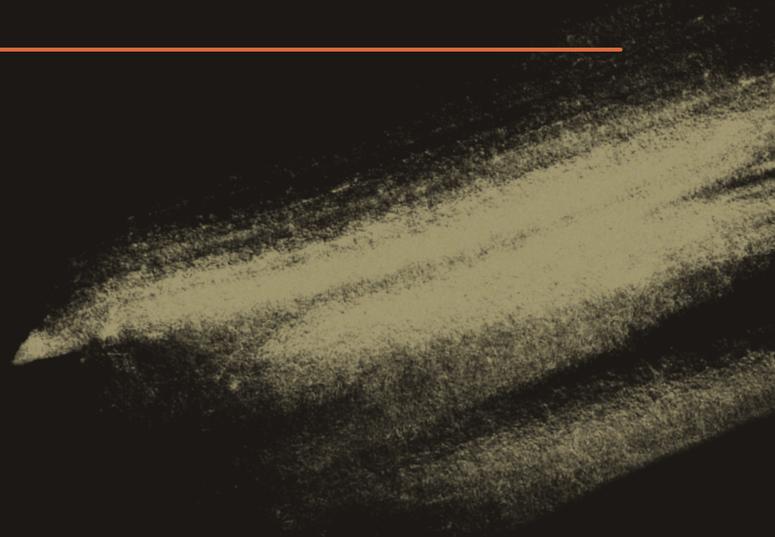
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# CHAPTER 1

# INTRODUCTION

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# CHAPTER 1

## INTRODUCTION

### 1.1 BACKGROUND OF RESEARCH

Landscape maintenance is every so often being called groundskeeping. It is an art keeping the landscape healthy, clean, safe and attractive when we speak about parks or gardens. Using the proper tools, supplies, knowledge, and skills, the landscape contractor may plan or carry out annual plantings, schedule periodic weeding, fertilizing, gardening and other lawn care to protect and improve the topsoil, plants and garden accessories. Maintaining a landscape refers to the process to resist deterioration. It means keeping the landscape in perfect condition.

Nevertheless, there is a problem with this approach: turf, flowers, shrubs, and trees are living things, so they will change and evolve constantly. Predominantly, it would involve maintaining the softscape by trimming the leaves as well as watering the plants. Sometimes, it might involve a hardscape where it includes rearranging the planter box.

The aim of a landscape is many and varied, and gardens and open spaces seldom serve a single purpose. Thus, any area of amenity land may be managed to provide pleasant views or appearance, screening or shelter, nature conservation, horticultural excellence, botanical variety and education, space for sport and recreation, job-creation, or leisure gardening (Parker & Brian, 1989). Many of these purposes will be immediately self-evident from the layout of the land, but, in many others, the circumstances may have

changed since the site was first laid and so obscured the original purpose. Therefore, whenever the maintenance is being planned or reviewed, it is essential to have a clear idea of the use and functions of the land.



**Figure 1.1 The scenic and historic scene of Taman Tasik Taiping, Perak.**

**Source: Google image**

For public open space, the process of maintenance is somewhat more complicated (Parker & Brian, 1989). Different individuals or groups will have different ideas and aspirations for the land, and these have to be offset against the limitations of funds and even the political aspirations of the local authority. Some may favour nature conservation, and others seek relative formality or horticultural perfection. The style and intensity of maintenance will sometimes have a much more significant effect on the cost of upkeep than the organization or efficiency of carrying it out. In general terms, Parker and Brian (1989) highlighted that the more natural; or informal the layout and maintenance, the lower the cost.

Conversely, the more formal or removed from nature, the more expensive will be the result. The detail or complexity of a site's layout will also influence its maintenance cost, apart from the type of landscape and its degree of formality (Cook and Van Der Zanden, 2011). Simple layouts are much more easily maintained by powerful

machinery with fewer labour requirements for a given area. More complex layouts, with relatively small spaces, require much greater use of small equipment and manual labour and are consequently much more expensive to maintain.

Therefore, excellent and efficient maintenance plays an essential role in park safety. The issues of graffiti, garbage, vandalism, poorly maintained pathways, or planting contributed to a perception of lack of safety. These conditions insinuated that an area is uncared for and has a lack of supervision. If overlooked, a cycle of abuse is likely to occur in which legitimate users start to avoid an area as physical conditions deteriorate. The result is that parks can be taken over by inappropriate users and uses. Increased lighting, surveillance, maintenance and use of graffiti-resistant materials can decrease the occurrence and extent of graffiti, vandalism, and inadvertent damage in a park. In turn, the area will project an image of being well cared for, and users will feel safer. In general, well-maintained areas enhance perceptions of security. Hence, considering the importance of the public park to the community and how this is a critical link to landscape maintenance, there is a need for a cost-efficiency study that can set forth a strategy that best works to mitigate this issue.

## **1.2 STATEMENT OF ISSUE**

In landscape, the process of putting the plan into action, the work of the day-to-day maintenance, is the part that takes the most time, energy and cost. It is also the part that is the most obvious sign of any management and not surprising that it tends to dominate our attention, sometimes to the extent that the overall objective, the whole purpose of the exercise, can become obscure or even forgotten. Parker and Brian (1989) highlighted that the efficiency of the day-to-day maintenance is essential in terms of

cost, but this can be too little real effect if it produces the wrong or undesirable results. Therefore, Parker and Brian (1989) accentuated that setting up the objectives is an essential first step if the manager is going to steer the ship of maintenance in the right course.

In Malaysia, thousands and even millions of Ringgits have been spent yearly by the local authorities to maintain our public park. The Star (2015) reported through an alarming statement, 'Public Parks in need of maintenance', several neighbourhoods' parks that have been built with excellent facilities for the public but are being unkempt and deteriorating into disrepair. A vast amount of money has been spent on developing these parks and including the facilities like jogging tracks and the likes. Thus, it is regrettable to see the parks go to waste because of neglect and poor maintenance. Are all these issues further connected to the maintenance cost implication factor? Parenthetically, this proposal sought to evaluate the cost efficiency for Malaysia public park maintenance and further recommend the sustainable and cost-effective public park maintenance practice in Malaysia.

### **1.3 AGENDA OF RESEARCH**

#### ***1.3.1 Research Question***

This research revolves around (one key) research question: How to effectively maintain urban public parks in Malaysia?

This will focus on how the Local Authorities and Landscape Maintenance Operators perform related maintenance works with less expenditure, human resources and time.

There will be two subsidiary research questions in the research:

- a) What are the attributes and parameters in urban parks maintenance?
- b) How does these attributes and parameters impact the maintenance cost?

### ***1.3.2 Aim and Objectives of the Research***

This research aims to evaluate the cost implication on the Malaysian public park.

Hence the research objectives that have been outlined for this research include:

- i. To analyse the existing public park landscape maintenance practice in Malaysia
- ii. To analyse the cost implication on public park maintenance practice in Malaysia.
- iii. To propose and recommend the sustainable and cost-effective public park maintenance practice in Malaysia.

### ***1.3.3 Research Intent***

Acting in response to the gap in the literature about landscape maintenance in Malaysia; therefore, this research aims to evaluate the cost implication on the Malaysia public park. The findings of this research will further guide the local authorities in Malaysia in establishing the best maintenance criteria with cost efficiency and further propose and recommend sustainable and cost-effective public park maintenance practices in Malaysia.

## **1.4 SCOPE AND LIMITATION OF RESEARCH**

The scope of this research is limited to:

1. The study of the urban park and similar classifications in relation to effective landscape maintenance.
2. Proposal and suggestion are in its generality due to the short duration of the study (6 months)

## **1.5 RESEARCH METHODOLOGY**

In general, this research applied a mixed-method approach. However, the central study strand remains qualitative despite a questionnaire method (quantitative) that was used to generate and establish the checklist for urban park landscape maintenance. 30 samples from landscape contractors, landscape consultant firms, and local authorities (Landscape Departments) in Malaysia will be gathered to formulate the first phase analysis. The findings of this quantitative survey through the first phase analysis will further guide establishing the best criteria for urban park landscape maintenance, thus guiding the researcher to further develop a semi-structured (thematic) questionnaire that will be used during the interview sessions.

In reflecting upon this research topic, qualitative data is the fundamental base that can contribute to assessing the maintenance criteria in conjunction with cost efficiency and best practice. Hence for the second phase of data collection, a structured interview method will gather in-depth discussion related to maintenance criteria that subdue to cost-effectiveness and best practices. Therefore, 10 samples of respondents from

government officers, landscape contractors, landscape firms and academics within the landscape architecture industry will be gathered. These personnel are selected based on their expertise in landscape maintenance in Malaysia. Hence, the application of both qualitative and quantitative approaches provides more valid and holistic results in addressing research problems, answering research questions as well as enhancing the validity of the research findings.

## **1.6 STRUCTURE OF RESEARCH**

The research report consists of six chapters, the structure of which is described below:

### **Chapter 1 – INTRODUCTION**

The first chapter presents the overall structure of the research. It covers the background of the research, statement of issues and research questions, research aim and objectives, research hypothesis/research assumption, research scope and limitations, and the introductory of the research methodology. Conclusively, this chapter highlights the significance of the research and its contribution to knowledge.

### **Chapter 2 – LITERATURE REVIEW**

The second chapter exhibits literature reviews relating to the research topic. The literatures assist in establishing definitions of the key subject of the research. The investigation also helps in determining the Themes and Parameters pertaining to effective landscape maintenance.

### **Chapter 3 – RESEARCH METHODOLOGY**

The fifth chapter describes the methodology and procedure to be adopted to assess and measure *the cost implication on public park maintenance* in Malaysia. It also discusses the approach of the methodology, the scope of research, the process that determines an appropriate research design and the way the investigation is structured.

### **Chapter 4 – EXPERT VALIDATION ON THE CRITERIA OF SUSTAINABLE LANDSCAPE MAINTENANCE**

The fourth chapter showcase a review of the collected data and the assessment process in identifying the Themes and Parameters of the research. Subsequently, presenting the outcome of the first phase analysis that enhance the expert validation toward the designed criteria.

### **Chapter 5 – ANALYSIS OF LANDSCAPE MAINTENANCE TOWARDS COST IMPLICATION**

The fifth chapter discusses the influencing factors for public park maintenance and the cost implications. Discussion related to the critical component and procedure in park maintenance is also highlighted. In-depth discussions related to cost efficiency associated with effective operational maintenance and an argument on the utilization of technology for maintenance are also being debated. At the final section of this chapter, discourse related to sustainable landscape maintenance criteria associated with effective maintenance practise able to links to cost efficiency.

## **Chapter 6 – CONCLUSION & RECOMMENDATION**

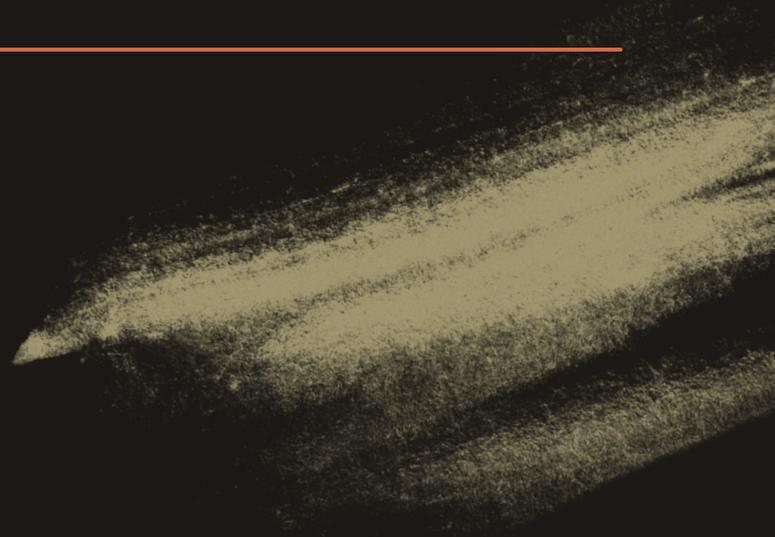
The sixth chapter concludes the research finding and discussions of the outcome. Discussions on the limitation, issues and problem arises during the course of the research are also highlighted. Ending with recommendations and suggestions on areas of that the researcher finds pertinent and in need of further investigation.

The following is the Literature Review chapter that deliberates on the establishing the themes and parameters of effective landscape maintenance, as well as the general practices to outline the theoretical foundation and scope of the research.

# CHAPTER 2

## LITERATURE REVIEW

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## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 INTRODUCTION**

The second chapter exhibits the literature review relating to the research topic. The literature assists in establishing the themes and parameters of effective landscape maintenance, as well as the general practices to outline the theoretical foundation and scope of the research.

This chapter is divided into six sections, including the Introduction. The second section covers the understanding of Urban parks in the Malaysian Context, and the third section envelopes around users' satisfaction and definition of urban parks and Landscape maintenance. The fourth section briefly highlights the nexus urban park and cost-effective maintenance. Subsequently, the following section covers the classification of Themes, Parameters and Attributes in maintenance via Literature Investigation, and the sixth section summarises the discussion of this chapter.

#### **2.2 URBAN PARKS IN THE MALAYSIAN CONTEXT**

Urban parks are essential components of everyday life and have significant contributions to users and urban residents, in particular for the quality of life of our increasingly urbanised society. The presence of natural assets and their components in the form of greeneries and water elements, and environmental services such as air, wind and microclimate stabilisation, provide social and psychological services, which are crucial for the comfort and wellbeing of

urban dwellers (Chiesura, 2004). The Malaysian Government is fully aware of the importance of greeneries, urban parks and landscape in the nation's development. Acting on the awareness, the National Landscape Department (NLD) or Jabatan Landskap Negara (JLN) has intensified their effort and formulated strategies to achieve the Beautiful Garden Nation. The three strategies are:

- **Driving the Nation Towards a Higher Income Economy** – through the provision of a conducive landscape environment with its own identity in order to attract local and foreign investments.
- **Ensuring holistic and Sustainable Development** – through effective landscape planning, development and management.
- **Focusing the well-being of the citizen** – by providing adequate landscape spaces for recreation and social interaction among Malaysian multi-cultural society.

(Jabatan Landskap Negara (JLN), 2011).

Subsequently, the National Landscape Department and the Institute of Landscape Architects Malaysia (ILAM) work collectively to materialise the government's aspiration in building the "Malaysian Beautiful Garden Nation". Ever since, many urban parks and gardens have been developed throughout the nations, especially in Malaysian's major cities, to increase urban residents' quality of life and beautify the nation (Ayob, Harun, & Mat Akhir, 2013).

### **2.3 URBAN PARKS – USERS SATISFACTIONS**

The aesthetic merit, historical significance and recreational usefulness of urban parks enhance the attractiveness of an urban park in the eyes of potential users. Natural elements such as trees, water and greeneries in general increase the value of the land (Kolimenakis et al., 2021).

Many empirical evidence signifies that parks and greeneries in the urban context contribute significantly to the urban residents' happiness and wellbeing (Saeedi & Dabbagh, 2021). Numerous studies have established the correlations between parks design, physical characteristics of urban parks elements and park maintenance with users' satisfaction (Chan, Si, & Marafa, 2018).

In addition, according to Bahriny & Bell (2020), parks supervision, quality and effective maintenance and access control in urban parks also contribute significantly to the feeling of safety, comfort and satisfaction among users. Liu & Xiao (2021) iterated that any well-used parks fulfil a certain level of users' satisfaction; thus, they require appropriately scheduled and effective maintenance to keep the high level of users' satisfaction and safety.

#### Definition of Key Components

This research revolves around urban parks landscape maintenance and the EVALUATION OF THE COST IMPLICATION ON PUBLIC PARK MAINTENANCE. The emphasis of this research is to identify cost implications that revolves around two domains, that are 'Urban Park' and 'Park maintenance'.

#### ***2.3.1 Urban Parks***

The creation and development of large open spaces and green areas have been an important agenda of all municipalities. The adaptation of these large green areas and open spaces in cities, known as urban parks, conform to the needs and demands of the government, local authorities, communities, and the general public (Chiesura, 2004; Mansor, Zakariya, & Harun, 2019). In Malaysia, Urban parks are planned to be places of leisure, recreation, entertainment and sporting activities which were heavily influenced by a "Picturesque and Gardenesque" landscape style (Roziya Ibrahim, Clayden, & Cameron, 2020).

The construct of urban green structures covers a wide-ranging of different elements, which includes urban forests, cemeteries, public and private gardens, community gardens and urban farms, sports complexes, street trees, square and plaza plantings, among others, that foster physical and psychological health (Konijnendijk, Annerstedt, Nielsen, & Maruthaveeran, 2013). In a broader perspective, Liu & Xiao (2021) defined *urban parks* as places that afford relief from the city crowd and polluted urban environment (air and noise) and provide critical ecological benefits to residents, habitat and alleviate urban heat islands.

For this research, we defined ‘urban park’ as ‘*demarcated open space commonly defined (by local authorities) as ‘parks’, with large areas of vegetation and water, and commonly reserved for public use’*.

### **2.3.2 Landscape Maintenance**

The upkeeping works to prevent or resist deterioration of a park’s initial planning and design is vital to ensure its longevity and achieve its objectives (Nam & Dempsey, 2019). It is challenging to keep the parks as most of their elements are living things and are constantly changing and evolving (Easton, 2009). Shamsudin (2013) defined *Landscape Maintenance* as part of landscape management that involve the routine works according to daily or weekly operations in caring of green areas, gardens and parks, which include all scheduled works such as site cleaning, grass cutting, weeding, pruning, fertilising, pest control and the likes.

Landscape maintenance involves the art and craft of landscape up keeping to ensure a clean and healthy, safe and attractive, of a park, garden, cemetery, institutional ground and the likes (Atwa, Ibrahim, Saleh, & Murata, 2019; Ayala-Azcárraga, Diaz, & Zambrano, 2019; Easton, 2009). For the context of this research, we are adopting Shamsudin (2013) definition ‘*landscape management that involves the routine works according to daily or weekly*

*operations in caring for green areas, gardens and parks, which include all scheduled works such as site cleaning, grass cutting, weeding, pruning, fertilising, pest control and the likes.*’, as it is more suited and relevant to the research and context.

## **2.4 URBAN PARK – COST EFFECTIVE MAINTENANCE**

The operation and running of maintenance works involve a considerable chunk of the park’s management budget. The current landscape practices and Standard Operation Procedure (SOP) in parks maintenance may no longer be efficient as it requires a great extent of maintenance (R. Ibrahim, 2016; Nam & Dempsey, 2020). The high maintenance cost triggered a financial burden to the states and federal governments, with smaller municipalities badly affected due to their limited maintenance budget.

As a result, proper and scheduled maintenance operations are often neglected or left out, causing significant declines in existing parks quality. The rectification of run down and poorly maintained parks has proven to be more complex and costly (Roziya Ibrahim et al., 2020). In addition to the national economic slowdown due to the current pandemic, budget for the landscape maintenance will continue to shrink (Mansor et al., 2019).

Therefore, there is an imperative need for a paradigm shift to engage in more sustainable and effective landscape maintenance, specifically at our urban parks and other public green and open spaces in general. Apart from being costly, the current maintenance practice of using a substantial amount of chemical fertilisers and pesticides, fossil fuel for machinery and irrigation is also environmentally detrimental (Roziya Ibrahim et al., 2020).

## 2.5 CLASSIFICATION OF THEMES

The investigations carried out on previous research have identified several premises involving the progression of maintenance stages. Table 2.1 below details the findings.

**Table 2.1 Main Keyword for Maintenance Progression Stages**

KEYWORDS	LITERATURE	AUTHOR
1- Planning, design and maintenance 2- Design and planning guidance, planning and management 3- Design and site condition 4- Initial design stage, ease of Management and care	Selection of suitable plants, species richness and lawn for Urban Parks for a diversity of environment was done during design and considered in its maintenance.	(Konijnendijk, Annerstedt, Nielsen, & Maruthaveeran, 2013).
	Design and planning guidance that tends to consider what comes after the implementation as a postscript. Two reasons may be attributed to this short-term approach to design, planning, and management: firstly, local government budgets are annual, which precludes a long-term view; and secondly, the provision and ongoing management of green and open spaces is not a statutory obligation in many countries around the world. In reality, this means that when budgetary constraints are imposed, public space management and maintenance are disproportionately and adversely affected.	(Nam & Dempsey, 2019).
	... numerous urban landscapes are resource hungry, requiring considerable inputs of water, energy, and nutrients, while some plant selections are inappropriate for hot environments. To ensure landscape sustainability and secure a healthy future, landscapes should be designed more efficient in their utilization of resources and parallel to the ecological and climatic conditions rather than against them.	(Atwa, Ibrahim, Saleh, & Murata, 2019)
	The main elements as site selection and layout, vegetation, water consumption, soil, air and energy, waste management, and material selection should be considered during the initial stage to achieve sustainable landscaping, ease of management and care.	(Wheeler & American Society of Landscape Architects (ASLA), 2009).
1- Site preparation, construction 2- Implementation stage and	From a landscape perspective, project construction and implementation team to clearly define roles and responsibilities, standards to be used, project protocols, frequency of information exchange points and data, what we seek are to create better-performing landscapes, specify products that are fit for purpose,	(Shilton, 2021).

effective maintenance 3- During design and stages of construction	deliver projects on time and to budget and require cost-effective maintenance.	
	Proper site preparation during construction works improves soil aeration and ensures seedling (vegetation) survival and growth.	(Schilling et al., 2020).
	During design and stages of construction, we should consider the proposed plants are with the site condition, local climate, and the issues of plant collocation (based on site condition). Many factors in the early stage of construction are taken into consideration so that the later stage can bring much convenience in terms of energy and maintenance, save a lot of human resources and material resources, and have a tremendous impact on the later development of the garden.	(Cao, 2021)
1- Preventive maintenance 2- Schedule maintenance 3- Regular maintenance	Preventive maintenance through regular inspection and repair to resolve minor problems before they become more extensive and expensive.	(Fathoni, Latief, & Machfudiyanto, 2020; Ighravwe & Oke, 2019).
	Regular maintenance is needed to avoid an uncomfortable environment, such as an unpleasant smell of water bodies, infertile plants and garbage.	(Mansor, Zakariya, & Harun, 2019).
	Planning for long-term management of an asset, even after it has been delivered, can include scheduled maintenance and replacement of features, thereby helping to predict and manage whole life costs.	(Shilton, 2021).

### 2.5.1 Identified Themes from Previous Research

Established from the above Literature Investigations, below are the identified Themes in the progression of the maintenance procedure.

- 1) Initial Planning and Design – During this stage, all planning and design ideas, concepts and solutions are committed to applying sustainable and effective maintenance that could evade high maintenance costs.
- 2) Construction and Implementation – During this stage, the programming, scheduling, and construction progress are committed to the quality control, operations to avoid/minimising site damage and recommendation and engagement of upcycling site wastes.

3) Schedule Maintenance – During this stage, outline the practical, ecological, and aesthetic objectives for a specific landscape. The plan describes the specific practices, tools, materials, and products for use to implement the landscape management and maintenance plan, along with a schedule of daily, weekly and monthly maintenance practices.

**2.5.2 Identified Parameters and Attributes**

The identification of parameters and attributes were predominantly covered during the desktop investigations and confirmed through the pilot survey. Table 2.2 summarises the Themes, Parameters and Attributes for this research.

**Table 2.2 Summary of Themes, Parameters and Attributes for Effective Maintenance**

THEMES	PARAMETERS	ATTRIBUTES
Initial Planning and Design	a) Plant Strategically	<ul style="list-style-type: none"> <li>i - Planting species must be suitable to site condition</li> <li>ii - Maximise the use of natives plants</li> <li>iii - Retain as much as possible the existing plants and vegetation</li> <li>iv - Applying the less-water consumption landscape design (Xeriscaping) - where possible</li> <li>v - Applying hydro zoning (group shrub planting) for effective water consumption</li> <li>vi - Trees to be the main component of plant's collection since it requires less maintenance in comparable to shrub and ground cover</li> <li>vii - Applying slow growing species in planting scheme for less maintenance</li> <li>viii - Plant selection should be based on the prevailing environmental condition</li> <li>ix - Utilize the nitrogen-produced plants from Leguminosae family especially for an unproductive soil (symbiosis approach-plants that can provide minerals to other plants)</li> <li>x - Applying rain garden or bioretention area</li> <li>xi - Applying bigger size of planting holes for areas with low annual rainfall</li> <li>xii - Consider to apply root barriers to control fast root development especially in urban landscape.</li> </ul>

	b) Sustainable hardscape Material	<ul style="list-style-type: none"> <li>i - Reuse of old building materials in new construction</li> <li>ii - Applying permeable paving (pervious concrete and asphalt) that easily allow filtration and flow of stormwater runoff</li> <li>iii - Use energy saving equipment such as solar energy lighting or solar water pump system</li> <li>iv - Use reclaimed materials as part of landscape design (reuse and recycle vegetation, rocks, and soil generated during construction)</li> <li>v - Use of local materials may promote sustainability and enhance the local character of the place</li> <li>vi - Ensure quality of materials and workmanship (as per design standards and specification)</li> </ul>
	c) Services and Maintenance Route Planning	<ul style="list-style-type: none"> <li>i - Design to consider the best service and maintenance route planning to minimise distance and fuel consumption</li> <li>ii - Control services and maintenance route to avoid unnecessary soil compaction and ground disturbance</li> </ul>
	d) Sustainable Drainage System (SUD)	<ul style="list-style-type: none"> <li>i - Applying the sustainable drainage system (SuDS) for a better surface (water) management and control</li> </ul>
	e) Water Source and retention	<ul style="list-style-type: none"> <li>i - utilise the available water body for plants watering</li> <li>ii - Create water retention area for access natural water/surface run-off</li> <li>iii - Apply rainwater harvesting</li> </ul>
Site Preparation, Construction and Implementation	a) Sustainable/Proper Site Clearing	<ul style="list-style-type: none"> <li>i - Minimise land destruction and soil compaction</li> <li>ii - Identify natural resources (rock boulders, Timber etc.) and reusable materials on site</li> </ul>
	b) Access Road, On-site Construction Route and Site Office	<ul style="list-style-type: none"> <li>i - To determine the best access road, construction route and site office to avoid unnecessary soil compaction and ground disturbance</li> </ul>
Schedule Maintenance	a) Fertilise Organically (where possible) /Mixture of Organic and Chemical Fertilisers	<ul style="list-style-type: none"> <li>i - Applying organic fertilizer where possible</li> <li>ii - Mixture of Organic and Chemical</li> </ul>
	b) Soil and Composting	<ul style="list-style-type: none"> <li>i - Recycling garden disposal materials to be used as mulching or organic fertilizers (cut grasses/grass clipping and dead leaves could be used for mulching. This helps to improve the soil texture and reducing the cost of disposal)</li> <li>ii - Effective practice of mulching for retention of soil moisture. Compost mulching may include dried leaves, grass clipping, branches, crushed stone, shredded bark, sawdust, coconut mulch, etc.</li> <li>iii - Applying soil aeration (for rich, fertile and properly drain soil)</li> </ul>
	c) Water Efficiently	<ul style="list-style-type: none"> <li>i - Applying drip irrigation system to reduce overspray towards other plants or structure.</li> <li>ii - Applying root watering system for high efficiency (enable water, oxygen, and nutrients to bypass compacted soil thus easily reach the tree root system).</li> <li>iii - Creating irrigation zones for efficient watering system.</li> <li>iv - Utilizing super absorbent polymer (SAP) for improving water use efficiency (growing gel for water retention). This additional water holding materials can be added in planting media- natural fibers and no-toxic gel (during the initial plant growth).</li> <li>v - Practice rainwater harvesting for effective use of water source especially for watering the plants.</li> </ul>
	d) Pruning and Shearing Strategically	<ul style="list-style-type: none"> <li>i - Pruning is a long-term maintenance strategy and should be done by trained personnel. Types of pruning may include structural pruning, clow cleaning, crown thinning, crown restoration, etc.</li> <li>ii - Conducting tree risk assessment for tree safety management.</li> </ul>

	e) Pest and Weed Control	<ul style="list-style-type: none"> <li>i - Applying the Integrated Pest Management (IPM) for an effective and environmentally sensitive approach to pest management.</li> <li>ii - Include in the maintenance program for pest and disease control.</li> <li>iii - Perform weeding and loosening the soil.</li> </ul>
	f) Minimising Fuel Consumption	<ul style="list-style-type: none"> <li>i - Choosing hybrid vehicles and alternative energy source for landscape maintenance tools and equipment.</li> </ul>
	g) Sustainable Tools and Equipment	<ul style="list-style-type: none"> <li>i - Use advance technology in maintenance such as woodchippers machine to solve the problem of large dumping ground space and support in recycling practices</li> </ul>

## 2.6 SUMMARY

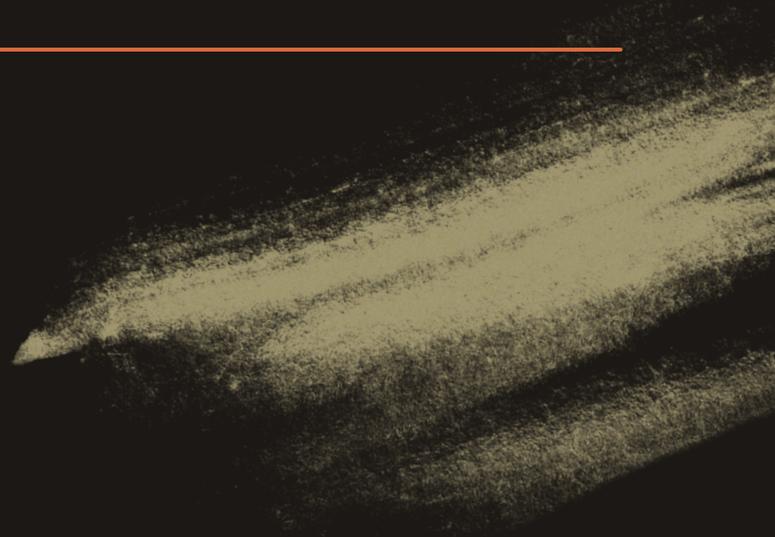
The development of large open spaces and green areas have been an essential agenda of all municipalities. The adaptation of these large green areas and open spaces in cities, known as urban parks, conform to the needs and demands of the government, local authorities, communities, and the general public. In Malaysia, Urban parks are planned to be places of leisure, recreation, entertainment and sporting activities that need to be maintained to ensure they function as intended.

The Literature Investigation in this chapter, through examination of previous research and publications, helps construct the definition of urban park and landscape maintenance, thus, clearly overlaid the research direction. The investigations also identified the respective themes, parameters and attributes that are pertinent and able to steer the course of this research meritoriously. The following chapter discusses the research methodology employed in uncovering the association between urban park maintenance and cost-effective maintenance practices.

# CHAPTER 3

# RESEARCH METHODOLOGY

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## CHAPTER 3

### RESEARCH METHODOLOGY

#### 3.1 INTRODUCTION

This chapter discusses the methodological framework applied to this research. Section 3.2.1 further highlights the selection of research design and strategy that effectively addressed the statement of the issue discussed in Chapter 1. In evaluating the cost implication on public park maintenance, this research applied a mixed-method procedure that implemented the ‘explanatory sequential design’ (Creswell, 2018). A sequential timing occurs when two distinct phases of data collection and analysis are established. In particular, the central strand of this research remains qualitative. However, the quantitative method was used to select the first phase data collection and analysis (expert validation on the landscape maintenance checklist) before proceeding to the second phase data collection through a qualitative procedure.

Prior to the establishment of research design, section 3.3 further discusses the selected research methods: (1) questionnaire survey that aims to validate the expert’s selection of criteria and parameters for landscape maintenance checklist; and (2) semi-structured interview involving experts within Malaysian landscape industry (qualitative inquiry that generated the mixed-method procedure for this study). In distinguishing data for analysis, the discussion in section 3.4 will consider how this quantitative data and qualitative data will be analysed and presented to generate research findings precisely. The final stage of this chapter presents the

methodological framework indicating the relationships between all the methods applied and how these approaches lead to the generation of results and research conclusions.

## **3.2 RESEARCH DESIGN AND STRATEGY**

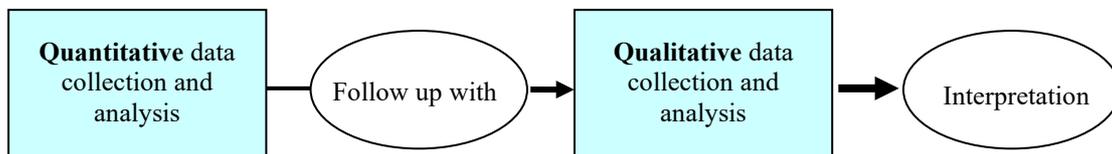
### ***3.2.1 Mixed Methods Research***

This research aims to evaluate the cost implication on the Malaysian public park's maintenance, the research design adopted for this study involves the mixed-methods approach. The following research questions guided the final decisions in adopting the methodological approach: (1) What are the attributes and parameters in urban parks maintenance? (2) How do these attributes and parameters impact the maintenance cost? have further influences on selecting the research design. In reflecting the focus of the research, qualitative inquiry and procedure stand as the key strand that contributes to the final assessment of the study.

Tashakkori and Creswell (cited in Creswell & Plano Clark, 2011), argue that because the mixed method research uses both qualitative and quantitative research approaches to accumulate data for analysis, it offers the ability to amalgamate the results and thus delineate research conclusions. (Creswell, 2018) explain that the paradigm of mixed method research involves mixing methods to address their methodological and philosophical orientations. In addition, Collins, Onwuegbuzie, and Sutton (cited in (Johnson, Onwuegbuzie, & Turner, 2007, p. 116) distinguish four reasons for conducting mixed method research that includes; 'participant enrichment', 'instrument fidelity', 'treatment integrity', and 'significance enhancement'. Hence, Ahmad (2018) concluded that applying both qualitative and quantitative approaches provide more valid and holistic results in addressing research problems, answering research

questions, and enhancing the validity of research findings. Therefore, the mixed methods enable researchers to better comprehend and corroborate findings in greater depth.

In establishing the attributes and parameters in urban park maintenance and its impact on the maintenance cost, this research adopts the explanatory sequential design prototype by Creswell and Plano Clark (2011). Significantly Creswell, Plano Clark, et al. (2011, p. 82) highlight that ‘the overall purpose of this design is to use a qualitative strand to explain initial quantitative results’. As illustrated in Figure 3.1, this prototype design begins with the data collection and analysis of the quantitative data. Hence the finding of phase one analysis will signify the attributes and parameters for the urban park maintenance checklist. This phase is followed by the qualitative data collection and analysis (phase two) that focuses on the maintenance cost impact guided by the first phase findings.



**Figure 3.1 Creswell and Plano Clark prototype of the explanatory sequential design adapted for this research.**

Source: Reproduce illustration from Creswell and Plano Clark (2011, p. 69).

The shift that occurs from postpositivist (quantitative approach) to constructivist (qualitative approach) orientation offer multiple perspectives or viewpoints in comprehending the sustainable and effective maintenance parameters (checklist) that resulted in cost efficiency maintenance for the Malaysia urban public park.

### **3.3 RESEARCH METHODS**

#### ***3.3.1 Questionnaires and Respondents***

##### **3.3.1.1 Questionnaire Design**

The mixed methods research applied for this study also adopted the explanatory sequential design. The first data collection phase involves the quantitative approach whereby a questionnaire has been selected as the main survey instrument. The focus of this survey is to validate the expert's selection regarding attributes and parameters for the urban park maintenance checklist. Hence two sections were developed for this questionnaire that includes Part A - respondent background and Part B- criteria of the public park maintenance (see Appendix). For the background section, general questions were outlined in this questionnaire sheet, including the respondent's gender, age, profession, and years of experience in the landscape industry.

A Likert scale of 1 to 10-point was used to identify the expert's rating pattern towards the outlined criteria for Part B. The 10-point numerical scales offer a 'greater reliance' on the respondent and familiarity towards the notion of 'rating out of 10' (Dawes, 2008; Hall, McDonald, & Peleg, 2018; Mohile et al., 2015). Dawes (2008) further highlighted that the positive responses for 10-point numerical scales are 6,7,8,9, and 10, with 8/10 as the average score. Under this section, expert respondents were asked to answer all questions and rate their preference criteria based on the scale range provided. Ten parameters were outlined in this questionnaire sheet, with detailed attributes listed for each category. These criteria were organized based on the specific theme derived from the literature review exercise. All criteria

highlighted in this questionnaire survey have comprehensively covered the initial landscape planning and design development phase, construction and implementation phase, and the scheduled maintenance period. Expert respondents were also encouraged to highlight or suggest any additional criteria (based on their personal experience) that best support the present outlined parameters. Through this focus, a valid and reliable criterion can be established and further aid in preparing the second phase of data collection involving the semi-structured expert interviews.

### 3.3.1.2 Respondent and Recruitment

In establishing the criterion and parameters for the landscape maintenance checklist, the focus of the respondent for this questionnaire survey will be drawn to experts who practise within the Malaysia landscape industry. Significantly, these experts range from academics, government sectors (including the local authority), landscape firms, landscape contractors and nursery operators. With their experiences and knowledge of landscape design, construction and landscape maintenance, it is expected that the responses received from these experts can establish a reliable and valid criterion for the landscape maintenance checklist. Furthermore, the sample size for the expert respondent, as suggested by scholars' range between 2 – 20 individuals (Armstrong, Cohen, Eriksen, & Cleeland, 2005; Colson & Cooke, 2017; Rodrigues, Adachi, Beattie, & MacDermid, 2017). However, due to the 'varies application of and implementation by', namely, Consultant, Contractors, Local Authorities and Private Agencies, we opt for Rodrigues's and Armstrong's approach by having 15 expert panels for the validation process. The identification of these expert panels was based on ILAM (Institute Landscape Architecture Malaysia) directory members.

### 3.3.1.3 The Survey Procedure

As highlighted in 3.3.1.2, the 15 identified expert panels were approached and invited to participate in the survey via emails and phone calls; and all invited panels had confirmed their participation. All panes were furnished with a set of questionnaires, and they were given one week to return the completed responses. All processes were done online due to Covid-19 MCO restriction, and the survey was conducted from July 2021.

## 3.3.2 *Semi-structured Interviews*

### 3.3.2.1 The Semi-structured Questionnaire Design

Subsequent to completing Phase 1 content validation by the experts, the next stage is data collection to answer Research Question- How do these attributes and parameters impact the maintenance cost? In Phase 2 of data collection - the qualitative method utilising the semi-structured interviews were carried out. This Semi-structured Interview process allows the interviewees to share their reflections on landscape maintenance and gives the interviewees freedom to articulate their opinions on other subject matters pertinent to the research. The Semi-structured Interview comprises three sections (see Appendix).

In Part A, the interviewees were required to complete the general background questions, while in Part B, eight semi-structured questions were designed to comprehensively cover effective landscape maintenance and its relation to operational cost implication. Questions related to their personal experience in handling effective landscape maintenance linked to efficient operational maintenance costs were also highlighted. In addition, Part C requires the interviewees to state significant judgment and provide rationale statements over criteria and

parameters established in phase 1 findings. The interviewees were also invited to state any additional criteria that could enrich the findings for this study.

### 3.3.2.2 Respondent, Recruitment and Procedure for Conducting the Semi-structured Interview

Since this qualitative method focuses on obtaining rich data collection that can draw comprehensive findings while attaining the study aim, the selection of sample and the sample size is the central focus of this exercise. The experts ranged from academic, government sectors (including the local authorities), private sectors ranging from landscape firms, landscape contractors, nursery operators, and developers. In particular, Malterud, Siersma, & Guassora (2016), Barbour (2014) and Morse (2000) argue that 6-10 samples with diverse experience were sufficient to reach saturation. Guided by these scholars, hence ten interviewees were selected for this exercise.

Upon establishing the expert name list, invitation letters were sent via email to obtain their consent for participating in this semi-structured interview session. The interview schedule was outlined to identify the expert's availability and suitable time slot. Due to MCO restrictions that prolonged until September 2021, these virtual interviews were conducted using the Google Meet platform, where all sessions were recorded. Each session was organised between 30-45 minutes long.

### 3.4 ANALYSIS OF DATA

With the establishment of research design and strategy, together with the selected methods that have been finalised in Section 3.3, data analysis will be conducted based on two separate stages. Through this explanatory sequential design, quantitative data will be analysed based on the Percentage of Consensus of Agreement. Each expert was asked to rank using the 10-point Likert Scale (according to their knowledge, expertise and understanding) the level of importance of all attributes from the questionnaire relevant to effective maintenance linking to the reduction of maintenance cost.

All attributes with a Percentage of Agreement equal to or higher than a Cut-off Point Percentage of 80.0% were included in the semi-structured interview stage (with the second set of experts). The value of percentage considered as consensus - Percentage of Consensus of Agreement (PoCoA) had been reached was arbitrarily set at either 66.7%, 75%, 80% or 100% agreement amongst respondents during Pilot Survey (Ayob, 2020; Lau, 2010; Watson, Watson, Ackerman, & Gronvall, 2017). The calculation for Percentage of Consensus of Agreement is done by taking the Accumulated Given Rating by participants and divided by the Total of Maximum Rating [Maximum rating Point (= 10) x Number of Participants (N = 15)] and multiply by 100. The calculation used a simple percentage formula as follow:

$$\text{Percentage of Consensus of Agreement} = \frac{\text{Accumulated Given Rating}}{\text{Total Maximum Rating}} \times 100$$

For the second phase analysis, qualitative inquiry based on coding and thematic analysis will be used to extract findings from the semi-structured interview involving ten experts of various professional backgrounds.

### 3.5 SUMMARY

The methodological framework for this research is summarised in Figure 3.2 below

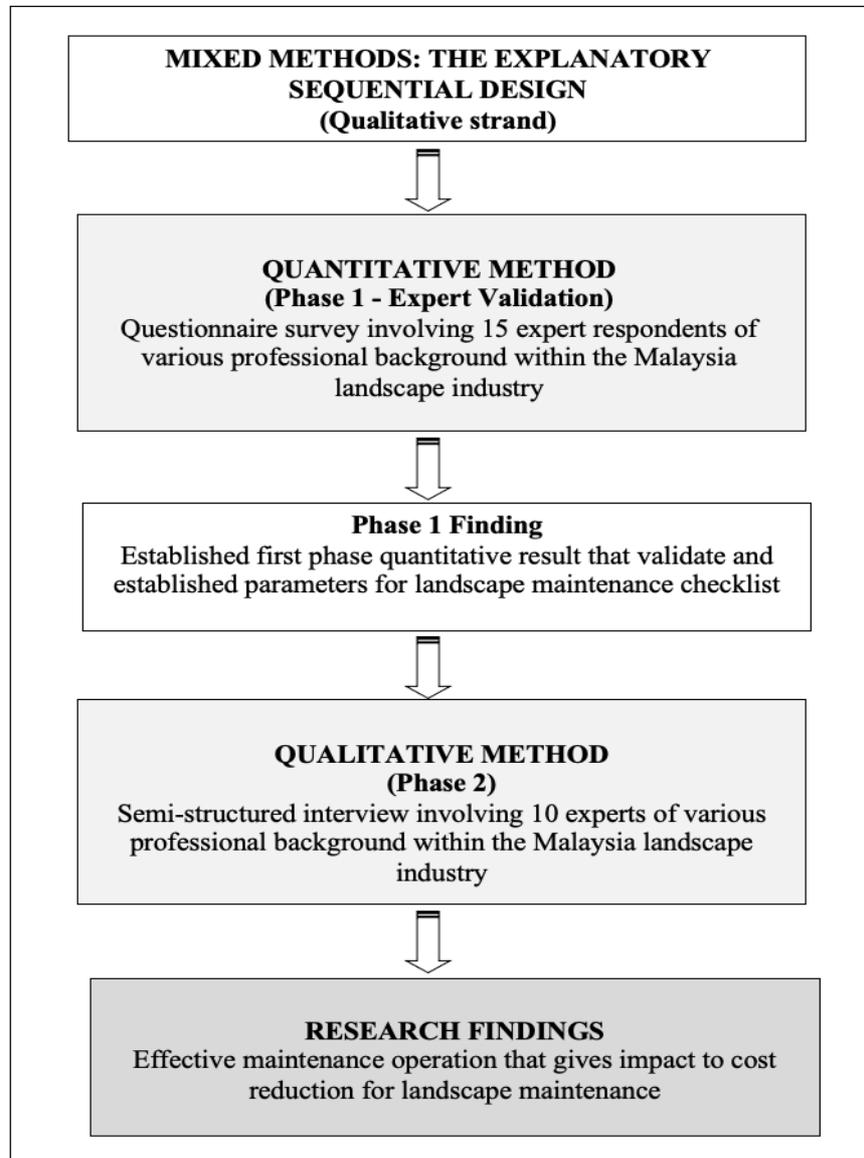


Figure 3.2 Methodological framework for mixed methods research.

Source: Adapted from Creswell & Plano Clark (2011)

The subsequent chapter deliberates on the expert validation findings toward the sustainable landscape maintenance criteria.

**CHAPTER 4**  
EXPERT VALIDATION ON THE  
CRITERIA OF SUSTAINABLE  
LANDSCAPE MAINTENANCE

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## **CHAPTER 4**

### **EXPERT VALIDATION ON THE CRITERIA OF SUSTAINABLE LANDSCAPE MAINTENANCE**

#### **4.1 INTRODUCTION**

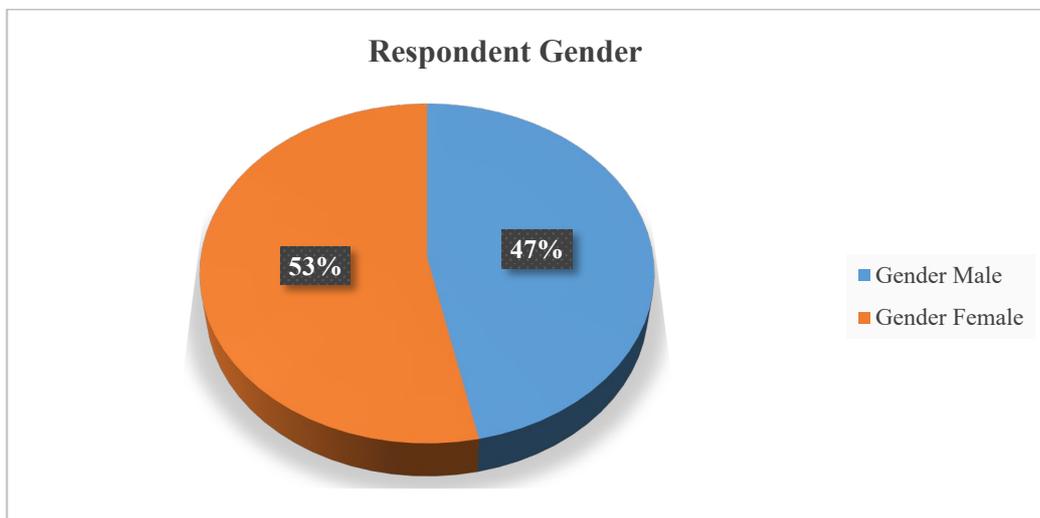
This chapter discusses the expert validation findings toward the sustainable landscape maintenance criteria. As highlighted in Chapter 2 and Chapter 3 of this report, the parameters and criteria for sustainable landscape maintenance outlined in the questionnaire survey were developed based on the literature review exercise and further tested its validity via an expert survey. Mainly, discussion regarding the questionnaire design, respondent selection and recruitment, and the survey procedure has been extensively established in Section 3.3.1 of this report.

To initiate discussion regarding the expert's criteria rating (since the Likert Scale was used to aid the expert's selection), Section 4.2 highlights the general information regarding the expert's background. The questions outlined for this section include information regarding gender, age, profession, and years of experience practising in the landscape industry. This information serves as the foundation that confirms the expert's knowledge and ability regarding landscape maintenance operation. Further Section 4.3 stands as the central findings for Phase 1 analysis that evidence expert's validation of the highlighted criteria. To emphasize, the Percentage of Consensus of Agreement (PoCoA) analysis that applied for this section has further demonstrated the significance of landscape maintenance parameters acknowledged by the

experts. Hence the summary of these findings will be detailed in Section 4.4, thus wrapping up the expert’s validation process for Phase 1 assessment and conclusion.

#### 4.2 RESPONDENT’S BACKGROUND

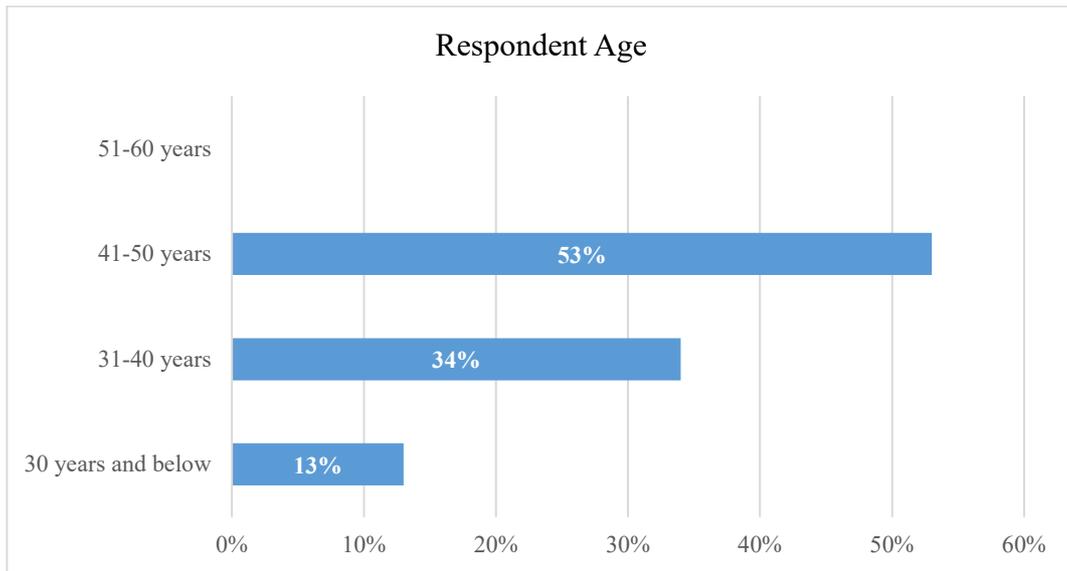
To establish expert bonding to this survey, general information was asked in Part A of this questionnaire. 53% of the respondent taking part in this survey were female, and 47% were male (see Figure 4.1). Figure 4.2 further illustrates that 53% of this sample is between 41-50 years. This was followed by 34% of the experts aged between 31- 40 years and only 13% from this survey sample age below 30 years. Furthermore, the majority of the expert stated that they have been practising in the landscape industry for more than seven years, with three respondents claiming to have 20 years of working experience in this industry. This information has further signified the expert's knowledge and ability regarding Malaysia's landscape maintenance operation practice.



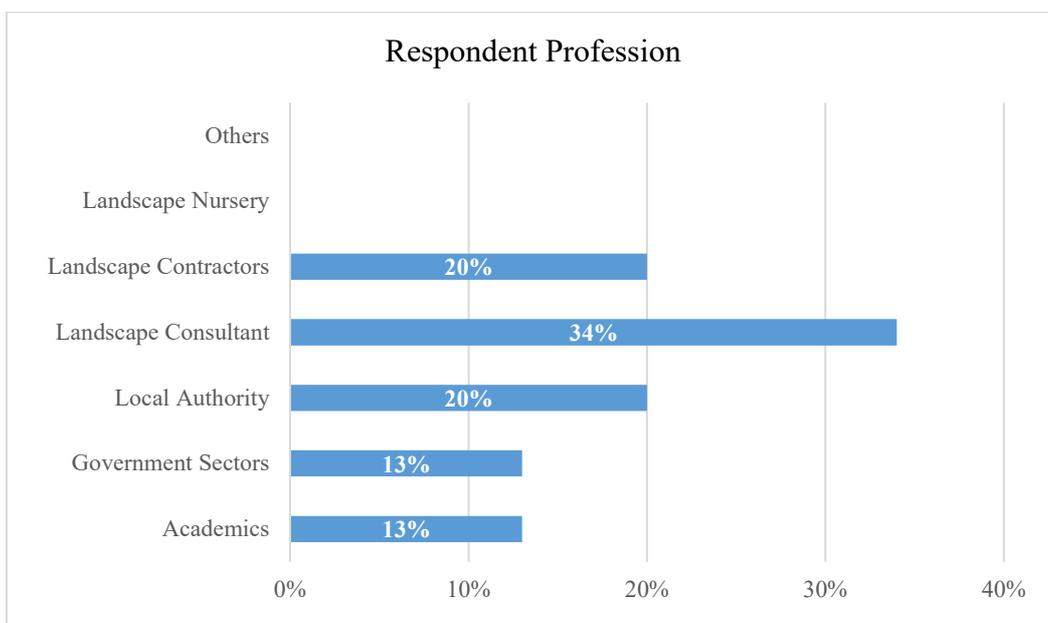
**Figure 4.1 Percentage of Respondent According to Gender**

The final question for this section has illustrated that the variety of respondent backgrounds with 34% of them practise as landscape consultants, 20% of the sample practise as landscape contractors as well as working with the local authority (Landscape Department), and the

remaining balance of the respondent work with the government sector and also practise as academic from the local higher institution (see Figure 4.3). From this various background and extent years of working experience, the researchers expected that the assessment established in Section 4.3 could enrich the study findings.



**Figure 4.2 Percentage of Respondent According Age Groups**



**Figure 4.3 Classification of Respondent According to Expert Profession**

### **4.3 VERIFYING THE CRITERIA FOR PUBLIC PARK MAINTENANCE: EXPERT SELECTIONS**

In Part B of this questionnaire survey, the experts were asked to rank between 1–10-point Likert Scale of criteria for sustainable landscape maintenance based on their knowledge, understanding and expertise. Under this section, ten landscape maintenance themes have been outlined, and this includes: 1- Plant strategically; 2- Fertilise organically; 3- Soil and composting; 4- Water efficiency; 5- Pruning and shearing strategically; 6- Pest and weed control; 7- Sustainable hardscape materials; 8- Minimising fuel consumption; 9- Sustainable drainage system (SuDs); and 10- Sustainable tools and equipment. All criteria highlighted in this questionnaire survey have comprehensively covered the initial landscape planning and design development phase, construction and implementation phase, and the scheduled maintenance period. Detailed analysis and findings of each theme based on the expert validation are presented in Section 4.3.1 – 4.3.10 below.

#### ***4.3.1 Plant Strategically***

Under Theme I-Plant Strategically, nine criteria have been developed for the expert validation process. The findings of this quantitative survey have manifested that the majority of the respondent strongly agree with these criteria highlighted below. Refer to the result illustrated in Table 4.1.

- (a) Applying native species in landscape design;
- (b) Landscape design should retain as much as possible the existing plants and vegetation;
- (c) Applying the less-water consumption landscape design (Xeriscaping);
- (d) Planting selection (through landscape design) should include various heights and habits to enhance the ecological value and biodiversity;

- (e) Applying hydro zoning (group shrub planting) for effective water consumption;
- (f) Trees to be the main component of plant's collection since it requires less maintenance incomparable to shrub and ground cover;
- (g) Applying slow-growing species in planting scheme for less maintenance;
- (h) Plant selection should be based on the prevailing environmental condition;
- (i) Utilise the nitrogen-produced plants from the Leguminosae family to improve the unproductive soil (symbiosis approach-plants that can provide minerals to other plants);
- (j) Applying rain garden or bioretention area;
- (k) Applying bigger size planting holes for areas with low annual rainfall; and
- (l) Consider applying root barriers to control fast root development, especially in the urban landscape.

As illustrated in Table 4.1, criteria 1(a) to (l) maintain a high score rating that ranges only between 7-10 points. The majority of results (except for criteria (g) pointed out from the Likert Scale score 10 (strongly agree) were above 50%, thus indicating the validity of criteria developed under this theme. Interestingly, parameters (a), (b), (d), (e), and (l) received a consistent score rating of 9-10 points (strongly agree). These results assertively portrayed the critical activities that have to be considered by all related parties involved in landscape projects for further success of the landscape maintenance operation (stages of the project involve from the initial planning stage until maintenance operation phase).

**Table 4.1 Survey Result for Theme I- Plant Strategically**

NO	CRITERIA FOR SUSTAINABLE LANDSCAPE MAINTENANCE	Likert Scale 1 to 10 point (1= Strongly Disagree; to 10= Strongly Agree)										
		1	2	3	4	5	6	7	8	9	10	
1.	Plant Strategically											
a.	Applying native species in landscape design.										40%	60%

b.	Landscape design should retain as much as possible the existing plants and vegetation.									20%	80%
c.	Applying the less-water consumption landscape design (Xeriscaping).								13%	20%	67%
d.	Planting selection (through landscape design) should include various heights and habits to enhance the ecological value and biodiversity.									20%	80%
e.	Applying hydro zoning (group shrub planting) for effective water consumption.									13%	87%
f.	Trees to be the main component of plant's collection since it requires less maintenance in comparable to shrub and ground cover.								20%	27%	53%
g.	Applying slow-growing species in planting scheme for less maintenance.							7%	20%	33%	40%
h.	Plant selection should be based on the prevailing environment condition.								13%	27%	60%
i.	Utilize the nitrogen-produced plants from Leguminosae family to improve the unproductive soil (symbiosis approach-plants that can provide minerals to other plants).								7%	13%	80%
j.	Applying rain garden or bioretention area.								13%	20%	67%
k.	Applying bigger size planting holes for areas with low annual rainfall.								7%	20%	73%
l.	Consider applying root barriers to control fast root development especially in urban landscape.									13%	87%

#### 4.3.2 Fertilise Organically

Under this theme, only one highlighted criterion has been developed. This criterion emphasises (a) Applying organic fertiliser instead of chemical fertilisers (see Figure 4.2). Interestingly, experts have validated this criterion with strongly agree where 93% of the experts confirm that this criterion can successfully link to effective and sustainable landscape maintenance operation.

**Table 4.2 Survey Result for Theme II- Fertilize Organically**

NO	CRITERIA FOR SUSTAINABLE LANDSCAPE MAINTENANCE	Likert Scale 1 to 10 point (1= Strongly Disagree; to 10= Strongly Agree)										
		1	2	3	4	5	6	7	8	9	10	
2.	<b>Fertilize Organically</b>											
a.	Applying organic fertiliser instead of chemical fertilisers.										7%	93%

**4.3.3 Soil and Composting**

For theme soil and composting, three criteria have been outlined under this section that includes;

- (a) Recycling garden disposal materials to be used as mulching or organic fertilizers (cut grasses/grass clipping and dead leaves could be used for mulching. This helps to improve the soil texture and reduce the cost of disposal);
- (b) Effective practice of mulching for retention of soil moisture. Compost mulching may include dried leaves, grass clipping, branches, crushed stone, shredded bark, sawdust, coconut mulch, etc.; and
- (c) Applying soil aeration (for rich, fertile, and properly draining soil).

The findings of this expert survey have demonstrated that criteria 3 (a) and (b) received an excellent 9-10 points scoring range, thus indicating that recycling garden disposal material and reasonable practice of mulching can improve soil condition while retaining the soil moisture. This scoring and percentage results portray that experts acknowledge the activities outlined through items (a) and (b) as these can successfully link to sustainable landscape maintenance practice (see Table 4.3). Experts also validated that applying soil aeration helps fertile and improves drain soil, with 60% of the survey sample strongly agreeing with this statement (rated with 10 points).

**Table 4.3 Survey Result for Theme III- Soil and Composting**

NO	CRITERIA FOR SUSTAINABLE LANDSCAPE MAINTENANCE	Likert Scale 1 to 10 point (1= Strongly Disagree; to 10= Strongly Agree)										
		1	2	3	4	5	6	7	8	9	10	
3.	<b>Soil and Composting</b>											
a.	Recycling garden disposal materials to be used as mulching or organic fertilizers (cut grasses/grass clipping and dead leaves could be used for mulching. This helps to improve the soil texture and reducing the cost of disposal).										33%	67%
b.	Effective practice of mulching for retention of soil moisture. Compost mulching may include dried leaves, grass clipping, branches, crushed stone, shredded bark, sawdust, coconut mulch, etc.										20%	80%
c.	Applying soil aeration (for rich, fertile and properly drain soil).									13%	27%	60%

#### 4.3.4 Water Efficiency

Another important parameter that was developed for the sustainable landscape maintenance checklist includes water efficiency. It is undeniable that water plays a vital role that links to plant growth and its survival. Hence, five criteria have been developed to support this theme, and these include:

- (a) Applying drip irrigation system to reduce overspray towards other plants or structures;
- (b) Applying root watering system for high efficiency (enable water, oxygen, and nutrients to bypass compacted soil thus easily reach the tree root system);
- (c) Creating irrigation zones for an efficient watering system;
- (d) Utilizing super absorbent polymer (SAP) for improving water use efficiency (growing gel for water retention). This additional water-holding material can be added in planting media- natural fibres and no-toxic gel (during the initial plant growth); and

- (e) Practice rainwater harvesting for effective use of water sources, especially for watering the plants.

The result illustrated in Table 4.4 has manifested that 93% of the experts strongly agree (rated between 9-10 points) with criteria (a) applying drip irrigation system being validated by the experts as it contributes to sustainable landscape maintenance. The same percentage of experts (rated between 9-10 points) have validated that creating irrigation zones can contribute to an efficient watering system. A similar percentage (93% with rated score 9-10 points) goes to criteria (d) applying super absorbent polymer (SAP) where experts have strongly agreed that this growing gel helps to retain and improve the usage of water if it is added in planting media, especially during the initial plant growth. A significant score is manifested for criteria (e), where a majority of the experts strongly agreed and validated rainwater harvesting as an effective and sustainable watering system, thus synergizing to water efficiency practice.

**Table 4.4 Survey Result for Theme IV- Water Efficiency**

NO	CRITERIA FOR SUSTAINABLE LANDSCAPE MAINTENANCE	Likert Scale 1 to 10 point (1= Strongly Disagree; to 10= Strongly Agree)										
		1	2	3	4	5	6	7	8	9	10	
4	<b>Water Efficiency</b>											
a.	Applying drip irrigation system to reduce overspray towards other plants or structure.							7%	0%	20%	73%	
b.	Applying root watering system for high efficiency (enable water, oxygen, and nutrients to bypass compacted soil thus easily reach the tree root system).							7%	13%	33%	47%	
c.	Creating irrigation zones for efficient watering system.								7%	26%	67%	
d.	Utilizing super absorbent polymer (SAP) for improving water use efficiency (growing gel for water retention). This additional water holding materials can be added in planting media- natural fibres and no-toxic gel (during the initial plant growth).								7%	33%	60%	
e.	Practice rainwater harvesting for effective use of water source especially for watering the plants.									20%	80%	

**4.3.5 Pruning and Shearing Strategically**

Theme V: Pruning and Shearing Strategically is the primary task involved during the operational maintenance phase. Under this theme, two criteria have been developed that cover:

- (a) Pruning is the long-term maintenance strategy and should be done by trained professionals; and
- (b) Conducting a tree risk assessment for tree safety management.

Significantly, experts have strongly agreed and rated scores between 7-10 points for both criteria. Table 4.5 depicts that 93% (score for both 9-10 points) of the experts strongly agreed with criteria (a). In addition to criteria (b), 80% of the experts strongly agreed with a tree risk assessment as part of the sustainable landscape maintenance checklist. The result obtained for both criteria demarcates the importance of pruning strategy and tree risk assessment as the sustainable activities included in the landscape maintenance checklist.

**Table 4.5 Survey Result for Theme V- Pruning and Shearing Strategically**

NO	CRITERIA FOR SUSTAINABLE LANDSCAPE MAINTENANCE	Likert Scale 1 to 10 point (1= Strongly Disagree; to 10= Strongly Agree)										
		1	2	3	4	5	6	7	8	9	10	
5	<b>Pruning and Shearing Strategically</b>											
a.	Pruning is the long-term maintenance strategy and should be done by trained personnel. Types of pruning may include structural pruning, crown cleaning, crown thinning, crown restoration, etc.							7%	0%	20%	73%	
b.	Conducting a tree risk assessment for tree safety management.							7%	13%	33%	47%	

**4.3.6 Pest and Weed Control**

Other than pruning and shearing strategically, pest and weed control theme developed for this checklist composed of 3 sub-criteria:

- (a) Applying the Integrated Pest Management (IPM) for a practical and environmentally sensitive approach to pest management;
- (b) Include the maintenance program for pest and disease control; and
- (c) Perform weeding and loosening the soil.

The survey result highlighted in Table 4.6 shows that experts have strongly agreed with all the suggested parameters. The experts rated a high score (with only 8 to 10 points) for all attributes, thus signifying these criteria' relevancy to compose as sustainable landscape maintenance checklist attributes. Of the three criteria highlighted in this theme, criteria (a) and (b) both received a higher percentage with 93% and 87% representing the 9- and 10-points rating scores. Nevertheless, within similar rating scores (9 and 10 points), 80% of the experts verified that weeding and loosening the soil are essential for landscape maintenance operation.

These results indicate that the experts acknowledge IPM, pest and disease control maintenance programs, and weeding and loosening the soil as the essential activities that resulted in sustainable landscape maintenance practices.

**Table 4.6 Survey Result for Theme VI- Pest and Weed Control**

NO	CRITERIA FOR SUSTAINABLE LANDSCAPE MAINTENANCE	Likert Scale 1 to 10 point (1= Strongly Disagree; to 10= Strongly Agree)												
		1	2	3	4	5	6	7	8	9	10			
6	Pest and Weed Control													

a.	Applying the Integrated Pest Management (IPM) for an effective and environmentally sensitive approach to pest management.									7%	53%	40%
b.	Include the maintenance program for pest and disease control.									13%	27%	60%
c.	Perform weeding and loosening the soil.									20%	33%	47%

#### 4.3.7 Sustainable Hardscape Materials

The criteria developed for this study do not cater only for soft landscape purposes but are comprehensive enough to include hard landscape, labour skill (quality), and machinery. Hence, the focus of Theme VII- Sustainable Hardscape Materials emphasizes the selection of walkway materials, energy-saving and reclaim items, and workmanship quality. Consequently, six criteria were composed for this theme which includes:

- (a) Reuse of old building materials in new construction.
- (b) Applying permeable paving (pervious concrete and asphalt) that easily allow filtration and flow of stormwater runoff.
- (c) Use energy-saving equipment such as solar energy lighting or solar water pump system.
- (d) Use reclaimed materials as part of landscape design (reuse and recycle vegetation, rocks, and soil generated during construction).
- (e) Use of local materials may promote sustainability and enhance the local character of the place.
- (f) Ensure quality of materials and workmanship (to enable all groundworks according to design standards and specifications).

**Table 4.7 Survey Result for Theme VII- Sustainable Hardscape Materials**

NO	CRITERIA FOR SUSTAINABLE LANDSCAPE MAINTENANCE	Likert Scale 1 to 10 point (1= Strongly Disagree; to 10= Strongly Agree)												
		1	2	3	4	5	6	7	8	9	10			
7	<b>Sustainable Hardscape Materials</b>													
a.	Reuse of old building materials in new construction.											7%	40%	53%
b.	Applying permeable paving (pervious concrete and asphalt) that easily allow filtration and flow of stormwater runoff.											13%	27%	60%
c.	Use energy-saving equipment such as solar energy lighting or solar water pump system.												20%	80%
d.	Use reclaimed materials as part of landscape design (reuse and recycle vegetation, rocks, and soil generated during construction).											7%	33%	60%
e.	Use of local materials may promote sustainability and enhance the local character of the place.												20%	80%
f.	Ensure quality of materials and workmanship (to enable all groundworks according to design standards and specification).												13%	87%

Similar to criteria VI discussed in Section 4.3.6, experts have rated 8-point scoring and above, thus indicating that they confirm all six measures constructed under theme sustainable landscape materials are relevant. Through Table 4.7, the high rated score is evident by criteria (c) use of energy-saving equipment, (e) use of local materials, and (f) ensure quality of materials and workmanship. These three parameters are getting 9 to 10 points scoring while the remaining criteria (a), (b), and (d) were also relevant as experts rated a high score (8-point and above) that explain their recognition toward these criteria establishment.

**4.3.8 Minimizing Fuel Consumption**

Further in Theme VIII, this section focuses on fuel consumption related to a green and sustainable environment. This parameter is developed to align and support the current

Malaysian aspiration toward a low carbon city goal. Hence, only one criterion was established under this section - (a) Choosing hybrid vehicles and alternative energy sources for landscape maintenance tools and equipment. Significantly, the experts rated a high score with 8-points and above (strongly agree), with 53% of the expert sample rated 10-points for this criterion. The result confirms that experts recognized this attribute that dynamically synergizes to a sustainable approach, linking to landscape maintenance practices.

**Table 4.8 Survey Result for Theme VIII- Minimizing Fuel Consumption**

NO	CRITERIA FOR SUSTAINABLE LANDSCAPE MAINTENANCE	Likert Scale 1 to 10 point (1= Strongly Disagree; to 10= Strongly Agree)													
		1	2	3	4	5	6	7	8	9	10				
8	<b>Minimizing Fuel Consumption</b>														
a.	Choosing hybrid vehicles and alternative energy source for landscape maintenance tools and equipment.											20%	27%	53%	

#### **4.3.9 Sustainable Drainage System**

This section highlights quantitative results that focus on the theme- Sustainable Drainage System. As discussed in Section 4.3.8, the green and sustainable approaches are the domain focus in developing criteria for landscape maintenance checklist. Since drainage system is also part of the landscape maintenance focus and as mentioned in 4.3, the consideration of this criteria development is not rigid to 'operational maintenance phase' only, but initially start from as early as the landscape planning and design stages. Hence, under Theme IX, criterion (a) Applying the sustainable drainage system (SuDS) for better surface management and control received a significant scoring result, where 93% of the experts rated 8-points and above (strongly agree) for this criteria rating. Subsequently, the findings of this survey exhibit the experts' recognition towards Theme IX establishment.

**Table 4.9 Survey Result for Theme IX- Sustainable Drainage System**

NO	CRITERIA FOR SUSTAINABLE LANDSCAPE MAINTENANCE	Likert Scale 1 to 10 point (1= Strongly Disagree; to 10= Strongly Agree)												
		1	2	3	4	5	6	7	8	9	10			
9	Sustainable Drainage System (SuDS)													
a.	Applying the sustainable drainage system (SuDS) for better surface management and control.								7%	13%	33%	47%		

**4.3.10 Sustainable Tools and Equipment**

The final theme designed for this checklist emphasises sustainable tools and equipment. The criterion designed under Theme X focuses on (a) using advanced technology in maintenance such as woodchippers machines to solve the problem of large dumping ground space and support recycling practices. Feasibly, the use of technology is seen as opportune in operational landscape maintenance. The utilisation of advanced technology in running landscape maintenance can offer significant benefits to maintenance operators. With this focus, the experts have rated a high score with a rating of 8-points and above (strongly agree), thus portraying this criterion's significance and relevancy in the sustainable landscape maintenance checklist (see result presented in Table 4.10). This result confirms the benefit of utilising advanced technology for landscape maintenance while supporting recycling practices that collaborate with sustainable and green approaches.

**Table 4.10 Survey Result for Theme X- Sustainable Tools and Equipment**

NO	CRITERIA FOR SUSTAINABLE LANDSCAPE MAINTENANCE	Likert Scale 1 to 10 point (1= Strongly Disagree; to 10= Strongly Agree)												
		1	2	3	4	5	6	7	8	9	10			
10	Sustainable Tools and Equipment													
a.	Use advance technology in maintenance such as woodchippers machine to solve the problem of large dumping ground space and support in recycling practices.									27%	40%	33%		

#### **4.4 SUMMARY**

The result presented in Section 4.3 enhanced the relevancy of the designed criteria as the majority of the experts have validated and confirmed that these criteria are significant for landscape maintenance checklist that comprehend the present green and sustainable approaches. Applying the Percentage of Consensus of Agreement (PoCoA) analysis, each expert is required to rank using the 10-point Likert Scale according to their knowledge and expertise, guided by the outlined checklist presented in the questionnaire. As explained in Chapter 3, the Cut-off Point Percentage for this analysis is 80%, and significantly the PoCoA analysis has demonstrated that the findings of this Phase 1 result indicated 91% of validity. Exceeding the Cut-off Point Percentage (80%), the experts validated the criteria developed under ten major themes and established as the domain checklist included in the semi-structured interview for the second phase data collection and analysis presented in Chapter 5.

**CHAPTER 5**  
**ANALYSIS OF LANDSCAPE**  
**MAINTENANCE TOWARDS COST**  
**IMPLICATION**

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## **CHAPTER 5**

### **ANALYSIS OF LANDSCAPE MAINTENANCE TOWARDS COST IMPLICATION**

#### **5.1 INTRODUCTION**

In this chapter, the phase two analysis that expanded from phase one findings is comprehensively discussed. Analysis involving ten experts for a semi-structured interview will further highlight issues related to the current landscape maintenance practice that links to its operational cost, thus attaining the research question outlined in Chapter 1. As discussed in Section 3.3.2, the selection of experts involved in this second phase of data collection varied from landscape consultants, contractors, developers, academic and government agencies, including the selected landscape departments established at the local authorities.

Section 5.2 further discussed the findings of effective landscape maintenance that links to cost implications. Discourse related to the critical component and procedure in park maintenance is also highlighted together with the standard operational maintenance associated with cost reduction. In addition, in-depth discussion related to cost efficiency associated with effective operational maintenance and an argument on the utilization of technology for maintenance also established in Section 5.2.4 - 5.2.5. Further in Section 5.3, analysis related to criteria established in phase one findings is also presented and discussed. The overall discussion that ties the findings of phase two analysis is further debated in Section 5.4, while the summary established in Section 5.5 is the final part of this chapter.

## **5.2 EFFECTIVE LANDSCAPE MAINTENANCE THAT LINKS TO COST IMPLICATION**

### ***5.2.1 'Park without maintenance is a waste?': A Review by the Experts***

To establish in depth discussion related to effective landscape maintenance operation, the experts were asked to answer a statement that highlighted 'park without maintenance is a waste?'. Significantly, all experts agreed with the statement because, from their perspective, the landscape is very dynamic since it involves a living entity that needs to be maintained in order for it to survive and sustain. It is 'such a waste' (Expert 4, 7, and 9) if the investment landscape is not adequately maintained since the client has spent a significant amount of money for park development. Towards the end, it is not in proper order. Furthermore, Expert 6 expressed that 'park and maintenance is very synonym and inseparable' since beautiful landscape portrayed as a landmark, given a significant image and identity to a place. Some discussions were drawn to Putrajaya, established with 10 well-maintained parks and beautiful landscape, thus being a symbolic image to the country.

'Maintenance is taking care of everything, including both softscape and hardscape' (Expert 1), which further encourages visitors to visit the park. However, suppose the maintenance is no longer intact. In that case, visitors will occasionally slowly decline due to some perception that poor landscape maintenance may cause hazards and danger to them, especially if it can harmfully threaten their children. Additionally, Expert 5 accentuated that from the soft landscape point of view, if the trees are not well maintained, it will incur a higher cost for maintenance in the future run. From these points, it is coherent that periodic maintenance is very important in ensuring that all parks (including neighbourhood park, community park, or

regional park) can sustain their function and aesthetic appearance, thus eliminating unnecessary spending.

### ***5.2.2 The Key Component and Systematic Planning in Park Maintenance***

Based on their knowledge and experience, the experts were asked about the key component of an appropriate procedure and systematic planning in park maintenance. The result has demonstrated that the experts agreed that the component and procedure of systematic planning should not be detachable from the cycle of landscape or, specifically, the park development. Hence, Expert 1 pointed out that 'if the client/landscape operator has money, but they fail to manage, it is such a waste because they do not know how to use these resources (including human resources and machinery) effectively', especially during the maintenance operation. This statement further highlighted that systematic planning for park maintenance is essential as it can facilitate maintenance operations in the long run. The finding of this analysis suggested that the key component on an appropriate procedure and systematic planning in park maintenance include:

- i. The landscape planning and design development phases

It is interesting to identify that all experts highlighted that good landscape maintenance should begin as early as the landscape planning and design development stage. Landscape designers should consider the sustainability of their constructed landscape, comprehending maintenance as part of the critical component during landscape design planning. This ensures that their practical design can facilitate the maintenance period since 'we have evidenced a lot of landscape designs (during the maintenance phase) have failed to similarly retain its aesthetic quality once the landscape is being

constructed' (Expert 4). Furthermore, experts also suggested that various professionals' involvement be included as part of the landscape design team. Expert 3 highlighted that higher maintenance cost is due to 'failure in design planning.' Thereupon, other than a landscape architect, it was recommended that for a more significant park development (e.g., for a community park or regional park) and especially for the mixed development planning, and involvement of a horticulturist, arborist, and ecologist to compose as part of the design team in advising on an appropriate selection of planting design, considering the expert competency and knowledge regarding the taxonomy, morphology, and physiology of plant materials. Expert 9 accentuated that 'wrong plant selection at wrong placement' will cause problems to maintenance, and in return, it increases the cost for landscape maintenance operation. For example, planting *Gardenia carinata* at the former swamp area resulted to the failure of plant survival. Another example highlighted by Expert 9 is the wrong planting integration that resulted in incompetence watering during the maintenance period (plants with less water requirement (*Bougainvillea sp.*) mix with plants with high water requirement-*Zephyranthes sp.*).

ii. Implementation phase

During the implementation phase, all technical aspects primarily related to softscape should comply with the standard specification outlined by the Jabatan Landskap Negara. This includes planting holes (arborist suggested that the reasonable planting hole size for new planting should be 2-3 times of the root ball size), proper staking or guying technique, root barriers (depending on the location of the tree), and the needing of other basic procedure to making sure that plants able to well sustain on site. This

project phase is also being highlighted by the expert as important systematic planning in park maintenance.

iii. Operational maintenance phase

The final part of the project cycle stands as the significant debate and focus by the experts. As part of the systematic planning, experts have concluded that the critical components during the maintenance period include:

- Knowledge and competency of the workforce involved during the maintenance period.
- The selection of maintenance contractor – adequate experience based on the scope of work and the scope of a given area should be the main criteria for contractor's selection before tender being awarded.
- The maintenance teams (workforce)
- Checklist and working schedule, which include short-term, medium-term, and long-term maintenance activities.
- Adequate tools and equipment, including machinery for maintenance

***5.2.3 Standard Operational Maintenance that Associates with Cost Reduction***

Regarding the standard operational maintenance that associates with cost reduction, the experts have highlighted essential factors that can successfully link to cost reduction for maintenance operation. This includes:

i. A complete maintenance schedules

As highlighted by the experts, complete maintenance schedules are the critical factor that steers maintenance operations efficiently and further corresponds to maintenance costs. These maintenance schedules should cover the entire maintenance cycle of the landscape and include all critical aspects of the activities that vary from hedge trimming, fall clean-up (dry leaves and branches removal), loosening the soil, grass cutting, weeding, watering, and plant health care (involving fertilizing, disease control, pruning, etc.). Experts also highlighted that all maintenance activities should be periodically organized and scheduled based on short-term, medium-term, and long-term actions that cover the whole cycle of the landscape maintenance program. Significantly, Expert 4, 5, 6, and 7 underscores that periodic maintenance can be associated with cost reduction because all contingency or ‘ad-hoc’ maintenance due to irregular maintenance operation will result in higher operational costs.

ii. Personal protective equipment (PPE)

Making the workplace safe by enforcing personal protective equipment (PPE) is another critical highlight by the experts. This equipment includes clothing, goggles, helmet, gloves, etc. The rationale of this highlight is that the maintenance workers are easily exposed to risk or hazards while completing their daily maintenance routine. Expert 5 accentuated that risk at work (minor injury), primarily related to significant maintenance operation such as pruning activity, is sometimes ‘unavoidable.’ Because part of the maintenance activities requires workers to handle dangerous maintenance tools such as chain saw, hedge trimming, etc.; consequently, these field workers are easily exposed to risk and injury. Notably, Expert 5 and 7 stresses that many injuries occur during maintenance operations if

the workers fail to comply with the standard operating practice, which requires them to use this protective equipment while working on their maintenance routine. Furthermore, avoiding injuries during the maintenance operation can be associated with cost reduction because the maintenance schedule can run accordingly without any delay of maintenance activities. In conclusion, the enforcement of PPE has aided in optimizing the workforce for maintenance without jeopardizing their safety.

iii. Design Phase and Implementation

Interestingly, experts highlighted that SOP during the maintenance period depends on the project scope (e.g., park maintenance may differ from rooftop maintenance). Expert 4 and 8 stresses the right selection of hardscape materials and the proper selection of plant materials that best correspond to cost and less maintenance operation. ‘Go less on small plants and go bigger for tree planting,’ claimed Expert 2. A good landscape designer should create a sustainable design that may reduce maintenance costs (Expert 10). In ensuring the long-lasting design impact (after being constructed), maintenance operation should embark as one of the design considerations while designing the landscape.

Furthermore, Expert 1,2, 7, and 8 accentuated the utilization of native and local species that successfully responded to any site condition of the design landscape. This condition further aid in restoring and sustaining the ecological setting of the design area. Other than native species, emphasis was also given to selecting the right tree species corresponding to less maintenance. Significantly, the majority of the experts emphasize *Khaya senegalensis* as species that should be avoided due to issues related to its root system and robust growth. Many incidents related to the tree falling within these few years are linked to this species.

The experts also mentioned that many local authorities in Penang and Selangor, especially in Putrajaya and Sepang, have authorized the operation to cut down *Khaya senegalensis* due to public safety measures.

iv. Staff competency in handling the maintenance operation.

The majority of the experts admitted that regardless of having a complete maintenance schedule if the workforce handling the maintenance operation is not competent, this factor might lead to the incompetency of maintenance practice and eventually contribute to cost increment for maintenance operation. A few highlights were drawn to the selection of a landscape maintenance contractor. For example, a civil background contractor was assigned to handle the landscape maintenance work (Expert 1, 4, 5, 7, and 10). With limited knowledge regarding the correct technique for tree pruning example, because of incompetency in knowledge and skill, it may lead to tree topping instead of performing crown thinning. From the arborist perspective, this action is considered a crime to the tree. Sadly, in the long run, this mistake destroyed the aesthetic appearance of the plants and further led to other plant health issues. Hence, Expert 4 and 5 underscore that training courses related to landscape maintenance can generally assist the issue of incompetent knowledge. From the above highlight, it is undeniable that knowledge and staff competency play a vital role in the success of the landscape maintenance operation.

#### ***5.2.4 Effective Operational Maintenance to Cost Efficiency***

Incomparable to the standard operation maintenance procedure highlighted in Section 5.2.3, this section further debates the effective operational maintenance that ties to cost efficiency. ‘Cost saving is not a short-term attempt but a long-term effort that should be initiated from as early as the landscape planning stage’ Expert 1 and 4. Since the study aims to evaluate the cost implication on the Malaysian public park, hence experts have suggested that effective maintenance that is associated to cost efficiency can be obtained by:

i. Getting a reliable maintenance contractor

To maintain a public park, the municipalities can manage the landscape maintenance themselves (in-house), or if the scope and area are extensive, they might outsource the maintenance work to the selected maintenance contractor. Hence, engaging a reliable maintenance contractor with knowledge and background in landscape maintenance is vital in ensuring that all maintenance cycles can be strategically accomplished, thus attaining good maintenance practice.

ii. Detailed scope of work for landscape maintenance contracts

A landscape maintenance contract will legally tie two parties to focus on the specific area with a detailed scope of work. As being highlighted by Expert 7, it is also necessary to include in the landscape maintenance contract a contingency sum for emergency backup, for example, heavy rain that resulted in mud flooding or strong winds that also impacted fallen trees. Additionally, Experts 4, 5, and 6 highlighted the contract duration for the landscape maintenance. Because the landscape is dynamic, a one-year maintenance period is insufficient, and unable to see the full bloom of the plant’s

growth. Therefore, two years to three years of maintenance contract will offer a better maintenance opportunity whereby investment in modern machinery and tools for maintenance can enhance the quality of the maintenance operation. Putrajaya is among the leading municipalities that commit this sufficient period (between 2-3 years) of the maintenance program.

iii. Knowledge competency

Particularly, Expert 4, 5, 7, and 9 stress the knowledge competency of the maintenance workforce. Giving an example of some maintenance work conducted by the foreign supervisor (example, the Indonesian), with limited knowledge on landscape maintenance, these foreign workers will follow the stated procedure blindly. Nevertheless, if the person is competent, he will know that some procedure is impropriated (for example, procedure related to fertilizing activity- using tablet and non-tablet fertilizer, both having a different period of application) and can be skipped because these competent workforces are aware of the cause and effect of each action (Expert 9).

In addition, Expert 4 highlighted the deficiency of knowledge in regards to root barrier implementation. To him, landscape consultants should become aware of the purpose of utilizing the root barrier for trees. However, sadly, even in the open spaces, the root barrier was used, which contrasts with this material's purpose. This is where experts pointed out the gap related to knowledge competency. From the expert point of view, root barriers should be laid along the major structure to avoid root disturbance and away from the hardscape structure. Hence root barrier patented the mechanical guide that redirects tree roots from causing damage to the landscape structure.

Notably, Expert 4 highlighted the appropriate soil mixture for the planter box used on the rooftop or the high-rise building, which differs from the standard soil mixture. Again, with knowledge competency, issues related to poor soil irrigation and soil compaction that impact plant growth on the rooftop can be eliminated. Moreover, Expert 6 stresses the high maintenance cost due to annual plants utilization in Putrajaya, where millions of ringgits have been spent a year for annual plant maintenance. Concerning this issue, Perbadanan Putrajaya has replaced the use of annual plants with perennial plants that are more cost-effective for its maintenance. Hence, it is undeniable that with specific knowledge related to plant selection, plant health care, and root growth, unnecessary practice can be avoided where towards the end, effective maintenance and cost-efficiency for landscape operation can be finally achieved.

iv. Recycling the landscape waste

Experts accentuated that landscape waste is not a 'dirty' waste (Expert 3,5,6,9,10) as it can be reused as a compostable organic item that helps to improve the irrigation soil condition of the plant materials. Giving example of Horizon Hill, Johor, a township under Gamuda Land where composting house project developed at this township a year ago, has successfully produced organic compost in less than six months. Expert 3 highlighted that effective microbe EM technology is used to encourage the composting of the landscape waste dumping (dried leaves and branches). With this technology, these microorganisms could expedite the composting process; hence, the harvested organic composition was applied to all landscape areas within the Horizon Hill township. Interestingly, Expert 3 highlighted the reduction of 25% of fertilizer usage upon this application, and significantly it resulted in a reduction of landscape

maintenance cost. Expert 3 also accentuated that this organic composting utilizing the EM technology can aid their maintenance operation by improving the soil irrigation abilities of their planted areas, thus aiding healthy plant growth, which again reduces the maintenance cost of their landscape. Notably, the garden waste recycling and composting initiative applied by the Gamuda Land is now expanded to all Gamuda Land townships throughout Malaysia (Expert 3).

v. Consistency of the landscape maintenance program

The majority of the experts agreed that a consistent and periodic maintenance operation could contribute to landscape maintenance cost reduction and cost-efficiency. In line with this statement, Expert 4,5,6, and 7 stresses that periodic operation has proven to minimize maintenance in the long run and eliminated unnecessary works due to plants overgrowth issues that may result in public park users' safety. Expert 5 highlighted that to cater to the overgrowth issues due to poor maintenance schedule, more workforce, machinery, and time needed to complete the maintenance activities, which lead to higher cost for maintenance operation comparable to a consistent maintenance program.

vi. The application of modern technology for machinery and landscape maintenance tools

Most experts highlighted the application of modern technology for landscape maintenance tools and machinery as an important factor that synergized to effective maintenance operation. Advance technology in landscape maintenance and, specifically, the maintenance tools able to expedite the maintenance operation. Examples of the maintenance tools and machinery highlighted by the experts include the grass mowing machine, leaf blower, hedge trimming, chainsaw, stump grinder,

woodchippers, backhoe, sky lift, etc. Expert 5 and 6 stresses that utilization of machinery can reduce the workforce on site. For example, cleaning up the waste disposal (example big branches) after punning activities are done requires machinery to speed up the work on-site instead of the traditional method of using large numbers of labours that took a long time to complete the task (see Figure 5.1 and 5.2). Expert 9 accentuated that landscape maintenance scope and methodology used to expedite the maintenance work (in this case, the use of modern machinery and tools) will result in effective maintenance and cost-efficiency.

With detailed discussion that highlights the pointed factors established by the experts regarding the effective operational maintenance associated to cost efficiency, experts have pointed out several places in Malaysia that best demonstrate the debated points. These include- Taman Wetland, Taman Botani, Taman Saujana Hijau, Taman Wawasan, Taman Pancarona and Taman Putra Perdana (Putrajaya); Eco Ardence (Shah Alam); KLCC Park (Kuala Lumpur); Taman Tasik Taiping and Gunung Lang recreational park (Perak); Hutan Bandar recreational park (Johor); and Penang are among the most highlighted public parks that received attention from the experts and being mention as practicing the effective operational maintenance in Malaysia.



Figure 5.1 Backhoe and lorry were used for landscape waste clean-up due to pruning activity in Seri Iskandar. Less than seven workers were involved in this maintenance operation.  
Source: Photograph by the researcher in November 2021.



Figure 5.2 Sky lift was used to expedite pruning activities in Bandar Seri Iskandar.  
Source: Photograph by the researcher in November 2021.

### ***5.2.5 Technology Vs. Cost Efficiency***

The majority of the experts agreed that modern technology employed in the operational maintenance practice can minimize or save maintenance costs. In terms of efficiency of modern machinery and landscape maintenance tools, it can assist the landscape operators in expediting their daily, weekly, or monthly maintenance routine, which further results in time-saving and effective maintenance practice. Other than the highlighted point, the number of labours involved in the maintenance operation is smaller than the traditional (manual) workforce, resulting in cost reduction. In addition, as discussed in Section 5.2.4, the current implementation of a maintenance contract that ranges between two to three years offers a better maintenance opportunity whereby the landscape contractor can affordably provide investment in modern machinery and tools for maintenance. Ultimately, the quality of the landscape maintenance operation is achievable; this further correspond to cost-efficiency.

### ***5.2.6 Expert Perspective Regarding the Maintenance Practices that Corresponding to Cost Minimization***

In the final section of the semi-structured questionnaire, experts were encouraged to share their personal experience handling landscape maintenance practices that best correspond to cost reduction. The findings of this qualitative interview highlighted that these cost reduction practices include;

- i. Nursery survey to identify alternative trees or other plant materials that suit to the proposed concept and maintaining the aesthetic impact with less maintenance cost for the design landscape.
- ii. Utilizing tablet fertilizer whereby the application of this fertilizer is only twice a year, yet the impact (quality of fertilization) is similar to the standard monthly practices.

Consequently, the workforce to conduct the landscape maintenance can be reduced; thus, cost reduction for maintenance operation is achievable.

- iii. For the landscape maintenance team, the contractor will make sure that a quarter of his team comprises experience workers (either skilled labour or semi-skilled labour) with past experience handling the landscape maintenance work. This would further assist in expediting the landscape work with fewer mistakes while completing their daily or weekly maintenance routine.
- iv. From the landscape contractor's point of view, all foreign field workers (especially from Indonesia and Bangladesh) should have a permit. Other than worked permits, identification of logistic to station these foreign workers are also crucial since the wrong placement of logistic will incur the cost of the landscape maintenance operation. This statement is linked to the penalty imposed by the client (in the form of payment reduction) if the supervising officer (SO) reported that the field workers arrive late at the maintenance site.
- v. Another aspect highlighted by the experts involves the application of modern technology for landscape maintenance tools that accelerate the maintenance operation and save time—for example, the use of a stump grinder in removing stumps after cutting down trees able to offer quicken action to complete the landscape work.

### 5.3 CRITERIA FOR THE SUSTAINABLE LANDSCAPE MAINTENANCE

#### CHECKLIST: A REVIEW

In the final section of the semi-structured interview, all the ten experts were asked to respond (agree, disagree, neutral or conditional) to the sustainable landscape maintenance criteria established in phase one analysis (detail discussion of these criteria established in Chapter 4 of this report). The findings of this interview are presented in Table 5.1 below.

**Table 5.1 The Sustainable Landscape Maintenance Criteria: A Review by the Experts**

NO	CRITERIA FOR SUSTAINABLE LANDSCAPE MAINTENANCE	EXPERT										REMARKS
		Agree (/), Disagree (X), Neutral (N), Conditional (C)										
1	Plant Strategically	1	2	3	4	5	6	7	8	9	10	
a.	Applying native species in landscape design.	/	/	/	/	/	/	/	/	/	/	
b.	Landscape design should retain as much as possible the existing plants and vegetation.	/	/	C	C	/	/	/	/	/	/	E3- Depending on the species and the condition of the plants. E4- Yes only if the site exists with rare species, useful, in good quality and has significant value.
c.	Applying the less-water consumption landscape design (Xeriscaping).	C	/	C	C	/	/	C	/	/	/	E1- Depending on the location and the placement of the plants. E3- Depending on the species and good irrigation E4- Depending on the location and the placement of the plants. E7- Depending on the area proposed.
d.	Planting selection (in landscape design) should include various heights and habits to enhance the ecological value and biodiversity.	/	/	/	/	/	/	/	/	/	/	
e.	Applying hydro zoning (group shrub planting) for effective water consumption.	C	/	/	/	/	/	/	/	/	/	E1- Depending on the location and the placement of plants.

f.	Trees to be the main component of plant's collection since it requires less maintenance in comparable to shrub and ground cover.	/	/	/	/	/	/	/	/	/	/	
g.	Applying slow growing species in planting scheme for less maintenance.	/	/	/	/	/	C	C	C	/	/	E6- Depending on the location and not applying to all areas. E7- Maybe not all areas E8- Depending on the location and not applying to all areas.
h.	Plant selection should be based on the prevailing environment condition.	/	/	/	/	/	/	/	/	/	/	
i.	Utilize the nitrogen-produced plants from Leguminosae family especially for an unproductive soil (symbiosis approach-plants that can provide minerals to other plants).	/	/	/	/	/	/	C	/	/	/	E7- expert questions on the suitability and to include this suggestion as part of the landscape design
j.	Applying rain garden or bioretention area.	/	/	/	/	/	/	/	/	/	/	
k.	Applying bigger size of planting holes for areas with low annual rainfall.	/	/	/	/	/	/	C	/	/	/	E7- Optional depending on the planting area
l.	Consider to apply root barriers to control fast root development especially in urban landscape.	/	/	C	C	/	/	/	/	/	/	E3- Depending on root barrier placement & material E4- Depending on root barrier location.
<b>NO</b>	<b>CRITERIA FOR SUSTAINABLE LANDSCAPE MAINTENANCE</b>	<b>EXPERT</b>										<b>REMARKS</b>
		Agree (/), Disagree (X), Neutral (N), Conditional (C)										
<b>2.</b>	<b>Fertilize Organically</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	
a.	Applying organic fertilizer instead of chemical fertilizers.	N	C	C	X	C	/	C	/	X	/	E1- Suggested for mix fertilizers. E2- Depending on the size of the project. Applicable for small area, but for large area it is recommend to apply for mix fertilizer (both organic and chemical). E3- Suggested for mix fertilizers. E4- Suggested for mix fertilizers to obtain full impact of plant growth. E5- Suggested for mix fertilizers to

												obtain full impact of plant growth E7- Suggested for mix fertilizers to obtain full impact of plant growth E9- Suggested for mix fertilizers to obtain full impact of plant growth. Total usage of organic fertilizer only will incur the maintenance cost.
<b>NO</b>	<b>CRITERIA FOR SUSTAINABLE LANDSCAPE MAINTENANCE</b>	<b>EXPERT</b> Agree (/), Disagree (X), Neutral (N), Conditional (C)										<b>REMARKS</b>
<b>3</b>	<b>Soil and Composting</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	
a.	Recycling garden disposal materials to be used as mulching or organic fertilizers (cut grasses/grass clipping and dead leaves could be used for mulching. This helps to improve the soil texture and reducing the cost of disposal).	/	/	/	C	/	/	/	/	/	C	E4- Provided that the leaves have decompose instead of new. E10- Need to expose to the relevant parties that practise in the landscape industry.
b.	Effective practice of mulching for retention of soil moisture. Compost mulching may include dried leaves, grass clipping, branches, crushed stone, shredded bark, sawdust, coconut mulch, etc.	/	C	/	C	/	/	/	/	/	/	E2- Because it will easily attract nuisance like bees to the area. So, to treat with caution. E4- Selected mulching impose. Do not apply to thick until it can ruin the root flare.
c.	Applying soil aeration (for rich, fertile and properly drain soil).	/	/	/	/	/	/	/	/	/	/	
<b>NO</b>	<b>CRITERIA FOR SUSTAINABLE LANDSCAPE MAINTENANCE</b>	<b>EXPERT</b> Agree (/), Disagree (X), Neutral (N), Conditional (C)										<b>REMARKS</b>
<b>4</b>	<b>Water Efficiency</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	
a.	Applying drip irrigation system to reduce overspray towards other plants or structure.	/	/	/	/	/	/	/	/	/	/	
b.	Applying root watering system for high efficiency (enable water, oxygen, and nutrients to bypass compacted soil thus easily reach the tree root system).	/	/	/	/	/	/	/	/	/	C	E10- Worried that due to technical issues, this system might be costly and no longer cost effective.
c.	Creating irrigation zones for efficient watering system.	/	/	/	/	/	/	/	/	/	/	
d.	Utilizing super absorbent polymer (SAP) for improving water use efficiency (growing gel for water retention). This additional water holding materials can be	/	C	/	/	/	/	/	/	/	/	E2- It is practical, but the gel is quite expensive. It is

	added in planting media- natural fibres and no-toxic gel (during the initial plant growth).											worried that cost efficiency of the maintenance is unable to attain.
e.	Practice rainwater harvesting for effective use of water source especially for watering the plants.	/	/	/	/	/	/	/	/	/	/	
<b>NO</b>	<b>CRITERIA FOR SUSTAINABLE LANDSCAPE MAINTENANCE</b>	<b>EXPERT</b> Agree (/), Disagree (X), Neutral (N), Conditional (C)										<b>REMARKS</b>
<b>5</b>	<b>Pruning and Shearing Strategically</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	
a.	Pruning is a long-term maintenance strategy and should be done by trained personnel. Types of pruning may include structural pruning, crown cleaning, crown thinning, crown restoration, etc.	/	/	/	/	/	/	/	/	/	/	
b.	Conducting tree risk assessment for tree safety management.	/	/	/	/	/	/	/	/	/	/	
<b>NO</b>	<b>CRITERIA FOR SUSTAINABLE LANDSCAPE MAINTENANCE</b>	<b>EXPERT</b> Agree (/), Disagree (X), Neutral (N), Conditional (C)										<b>REMARKS</b>
<b>6</b>	<b>Pest and Weed Control</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	
a.	Applying the Integrated Pest Management (IPM) for an effective and environmentally sensitive approach to pest management.	/	/	/	/	/	/	/	/	/	/	
b.	Include the maintenance program for pest and disease control.	/	/	/	/	/	/	/	/	/	/	
c.	Perform weeding and loosening the soil.	/	/	/	/	/	/	/	/	/	/	
<b>NO</b>	<b>CRITERIA FOR SUSTAINABLE LANDSCAPE MAINTENANCE</b>	<b>EXPERT</b> Agree (/), Disagree (X), Neutral (N), Conditional (C)										<b>REMARKS</b>
<b>7</b>	<b>Sustainable Hardscape Materials</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	
a.	Reuse of old building materials in new construction.	/	/	C	C	/	/	/	/	/	/	E3- Depending on the budget of the client E4- Depending on the material. To beware on the termite issue.
b.	Applying permeable paving (pervious concrete and asphalt) that easily allow filtration and flow of stormwater runoff.	/	/	N	/	/	/	/	/	/	/	E3- Not so practical
c.	Use energy saving equipment such as solar energy lighting or solar water pump system.	/	/	/	/	/	/	/	/	/	/	
d.	Use reclaimed materials as part of landscape design (reuse and recycle vegetation, rocks, and soil generated during construction).	/	/	/	/	/	/	/	/	/	/	
e.	Use of local materials may promote sustainability and enhance the local character of the place.	/	/	/	/	/	/	/	/	/	/	
f.	Ensure quality of materials and workmanship (to enable all works on ground are according to design standards and specification).	/	/	/	/	/	/	/	/	/	/	
<b>NO</b>	<b>CRITERIA FOR SUSTAINABLE LANDSCAPE MAINTENANCE</b>	<b>EXPERT</b> Agree (/), Disagree (X), Neutral (N), Conditional (C)										<b>REMARKS</b>

8	Minimizing Fuel Consumption	1	2	3	4	5	6	7	8	9	10	
a.	Choosing hybrid vehicles and alternative energy source for landscape maintenance tools and equipment.	/	/	C	/	/	/	/	/	/	N	E3- Depending on the size of the maintain area. E10- It's environmentally friendly but on cost point of view, it is quite pricey.
b.	Choosing the best and shortest route/ distance to the site or maintenance plot.	/	/	/	/	/	/	N	/	/	/	E7- Maybe
<b>NO</b>	<b>CRITERIA FOR SUSTAINABLE LANDSCAPE MAINTENANCE</b>	<b>EXPERT</b> Agree (/), Disagree (X), Neutral (N), Conditional (C)										<b>REMARKS</b>
9	Sustainable Drainage System (SuDS)	1	2	3	4	5	6	7	8	9	10	
a.	Applying the sustainable drainage system (SuDS) for better surface management and control.	/	/	/	/	/	/	/	/	/	/	
<b>NO</b>	<b>CRITERIA FOR SUSTAINABLE LANDSCAPE MAINTENANCE</b>	<b>EXPERT</b> Agree (/), Disagree (X), Neutral (N), Conditional (C)										<b>REMARKS</b>
10	Sustainable Tools and Equipment	1	2	3	4	5	6	7	8	9	10	
a.	Use advance technology in maintenance such as woodchippers machine to solve the problem of large dumping ground space and support in recycling practices.	/	/	/	/	/	/	/	/	/	/	

Source: Author 2021

## 5.4 DISCUSSION

As discussed in 5.1, the main focus of this chapter is to generate the phase two findings that respond to the research question- How do these attributes and parameters impact the maintenance cost? and answering the research objectives one and two that have been outlined in Chapter 1. With a major focus of diving into an evaluation of the cost implication on the public park maintenance, experts involved in this second phase data collection have significantly agreed that poor maintenance operation will lead to a higher maintenance cost incomparable to the systematic or consistent periodic maintenance. Notably, Expert 4 stresses that landscape design planning for the public park should consider less maintenance and not free maintenance. Of this statement, knowing plants are living things and dynamic in their

physiology and growth; therefore, poor maintenance routine will incur the maintenance operations. Eventually, more workers and machinery are needed to maintain the overgrowth and plants' health issues, resulting in higher and major maintenance operations.

Perhaps 'waste' as defined by the experts in Section 5.2.1 signifies the 'loss of investment' for developing the public park landscape due to poor maintenance operation. This further declines the visitors visiting the area upon considering safety issues, especially if it is related to the safety of their children. To retain the visual quality and appearance of a public park, maintenance should be the prioritise factor. Hence experts have concluded that the key component and systematic planning in park maintenance should consider from the landscape planning and design development phase, implementation phase, and operational maintenance phase. Expert 1 and 4 further accentuated that the operational maintenance phase is the most challenging phase whereby to retain the 'early beauty' of the park, a systematic maintenance routine (with detailed maintenance scope and schedule of daily/weekly/monthly/yearly) should be in the right position. Hence to make sure the success of the landscape maintenance phase, experts have highlighted five key components below:

- Knowledge and competency of the workforce involved during the maintenance period;
- The selection of maintenance contractor with sufficient experience background;
- The maintenance workforce involved in the project;
- Detail checklist and working schedule, which include short-term, medium-term, and long-term maintenance activities; and
- Adequate tools and equipment, including suitable machinery to handle the landscape maintenance area.

Furthermore, highlight was given to the initial design planning (this includes the selection and placement of the plant materials, the selection and placement of hardscape materials, drainage and irrigation, etc.) as the important stage that drive the final landscape maintenance activities, given impact to the maintenance operational cost. To engage discussion related to effective maintenance operation that may resulted to cost efficiency, interestingly six important highlights were being debated by the experts that suggest effective operational maintenance can be achieved by:

- i. Getting a reliable maintenance contractor;
- ii. Detail scope of work for landscape maintenance contracts;
- iii. Knowledge competency in handling the scope of maintenance involved;
- iv. Recycling the landscape waste;
- v. Consistency of the landscape maintenance program; and
- vi. The utilization of modern technology for landscape maintenance tools and machinery.

Significantly, the findings of this chapter suggested that the scope of landscape maintenance will define the methodology used to complete or expedite the maintenance work. This, in return, can successfully achieve effective maintenance practice with cost-efficiency. Having regards to this statement, the majority of the experts agreed that modern technology employed in the operational maintenance practice could minimize or save maintenance costs. Time, quality, and scope are the significant factors determining the concentration of the maintenance activities that synergize to the cost efficiency of the landscape maintenance operation.

The findings presented in the final section of this chapter (Section 5.3) further verify and trigger discussion among the experts related to the criteria established in Chapter 4. It is interesting to

identify that majority of the criteria highlighted in Table 5.1 have been thoroughly discussed by the experts in Section 5.2. This statement further justifies the relevancy and applicability of the suggested maintenance checklist that aids any landscape operators to achieve effective maintenance with efficient cost spending to operate the landscape maintenance works. Area of focus or theme developed under this checklist include:

1. Plant strategically
2. Fertilize organically
3. Soil and composting
4. Water efficiency
5. Pruning and shearing strategically
6. Pest and weed control
7. Sustainable hardscape materials
8. Minimizing fuel consumption
9. Sustainable drainage system
10. Sustainable tools and equipment

As illustrated in Table 5.1, the majority of the expert solidly agreed with the criteria 1 (a), (d), (e), (f), (h), and (j). Experts also agreed with criteria 1 (b) with the condition that the retained landscape, which consists of existing plants and vegetation, should possess a rarity of species, useful with significant value, and importantly the plants are in good condition (to ensure the safety of the users). Similar goes to criteria 1(c), where the expert majority agree with xeriscaping for landscape design less water consumption. Conditionally, they suggested that the idea of xeriscaping should not be implemented in the whole park area. The placement of this design should consider the plot location and the species that are tolerable to this setting.

Item 1(g) highlights the application of slow-growing species for less maintenance activities. Experts agreed with this suggestion but conditionally suggested that the application of slow-growing species only be used at the specific area (for example, at the main entrance to control the aesthetic and welcoming view to the visitors) and does not apply to the whole park development.

For criteria 1(i), the majority of the experts admit that utilizing the nitrogen-produced plants from Fabaceae or Leguminosae family can improve the unproductive soil, thus providing minerals to advantage other plants growth (symbiosis approach). However, Expert 7 questions on the suitability of this approach since, to him, sustainability of the landscape design is hard to achieve (in terms of cost and maintenance operation) due to changing of vegetation, especially for ground covers (this is because to his knowledge the Peanut or *Arachis hypogaea* is the type of species to be planted). However, if an appropriate species from the Fabaceae family is selected and easily integrated as part of the planting composition of the area, only then Expert 7 conclude that it is appropriate to include item 1(i) into the checklist. Item 1(l) also received much attention from the experts since Expert 3, and 4 have a conditional outline on the success of root barrier implementation, the material used, and its placement suitability.

Significantly Table 5.1 illustrated that item 2 received much attention to the criteria outlined in this checklist. The majority of the experts have conditionally agreed with the statement. Based on the expert's knowledge, applying organic fertilizer instead of chemical fertilizer may incur the maintenance cost due to the higher price of the organic fertilizer itself. Another highlight is that organic fertilizer is not specific in concentration incomparable to chemical

fertilizer for specific plant growth action. For example, if the plants need Nitrogen concentration for their growth, chemical fertilizer can offer this concentration (example 40% Nitrogen). They are only applied in small amounts; however full concentrated mineral can be obtained straight away by the plants. In this case, the landscape operator does not have to apply for a large amount of usage. Therefore, as suggested by the experts, a mixed amount of organic and chemical fertilizer is needed to support plant health and growth.

The expert also agreed that on items 3(a), (b), and (c) (see Table 5.1). However, special remarks were being highlighted for items 3(a) and (b) whereby the recycling garden disposal to be used as mulching or organic fertilizer and compost mulching; Expert 4 conditionally stresses that all leaves and branches should decompose and 'ready' as compost before it could be properly applied on plants. Expert 4 again emphasized the root flare caring and suggested that the appropriate thickness for compost mulching to not exceed 6 inches thickness. Significantly, the result in Table 5.1 illustrated criteria 4 to 10 received quite an excellent remark by the experts. The majority of them agree with all the criteria highlighted based on thematic parameters.

Drawing from the result highlighted in Table 5.1, criteria 4 (d) further demonstrated knowledge sharing by Expert 5 and Expert 7 on the utilization of growing gel- super absorbent polymer (SAP- industrial grade) for improving water use efficiency. Through their sharing, both experts have adopted this method and applied it to their projects, mainly in KL, Perak, and Kedah. This growing gel was added into their new planting holes (mainly used for the new planting) as water-holding material. By adding this growing gel, water can be retained for three days for every watering activity (see Figure 5.3-5.4). This further aided in developing new planting growth and consequently demonstrated effective maintenance practice with cost-efficiency.

With personal experience, Expert 7 accentuated that this growing gel only sells for RM400 for each 5 kg bag and can be utilised for 50 planting holes (so more or less, it will cost \$8 per planting hole). Expert 7 again stresses that this amount is still tolerable and that it can be implemented. All details related to the materials used should be spelled out in detail drawing and BQ before the tender is awarded.



Figure 5.3 SAP- industrial grade was used as water retention material for new shrub planting.  
Source: Courtesy image by Expert 5.



Figure 5.4 SAP- industrial grade were used as water retention material for new shrub planting.  
Source: Courtesy image by Expert 5.

## 5.5 SUMMARY

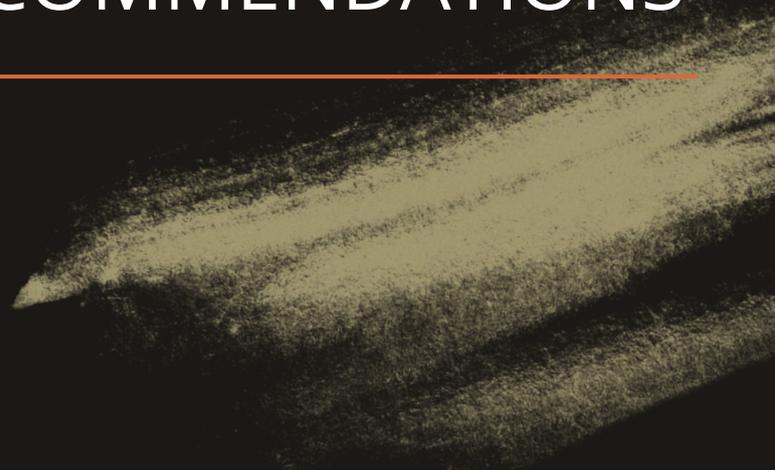
As highlighted in Chapter 3, the explanatory sequential design imposed for this research has successfully demonstrated the second phase data analysis drawn for qualitative findings. With various experts' backgrounds in the landscape industry, a solid research finding was successfully generated with detailed discussion established in Section 5.2-5.4. Acknowledging that landscape maintenance starts as early as the design planning phase, hence knowledge and competency, detailed working schedule, maintenance workforce, and adequate maintenance tools and equipment are the key components for systematic planning in park maintenance. Although simple, the personal protective equipment (PPE) (example like google, glove, helmet, boots, etc.) can support the safety practice of maintenance operation and further result in effective maintenance practice.

The experts debated six components that link effective maintenance with cost efficiency: getting a reliable maintenance contractor, detailed scope of work in maintenance contract, knowledge competency, recycling the landscape waste, consistency of landscape maintenance program, and modern technology. To expedite maintenance work (primarily covering large maintenance areas), new technology through modern maintenance tools and equipment and appropriate modern machinery can support maintenance activities. With less human resources and shorter time handling the maintenance routine, current technology use in maintenance can support and successfully correspond to effective maintenance practise with significant cost efficiency. To conclude, park without maintenance is a waste, and effective practice and consistent maintenance routine may further lead to cost reduction of maintenance in the long run.

# CHAPTER 6

## CONCLUSION & RECOMMENDATIONS

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## CHAPTER 6

### CONCLUSION AND RECOMMENDATIONS

#### 6.1 CONCLUSION

Recapitulating the study aim outlined in Chapter 1 that focuses on evaluating cost implication on public park maintenance, the major findings presented in Chapter 5 have further demonstrated the significant connection between effective maintenance and cost-efficiency. The phase one findings that were used to pave the second phase data collection and analysis have further answered all research questions and objectives designed for this study. It can be concluded that the current maintenance procedure is indeed ineffective and costly. Therefore, important highlights related to systematic planning in park maintenance further evidence the significant phase of landscape planning and design development to dominate the expert's judgment on effective maintenance. Since successful maintenance depends on the landscape design itself, the right selection of plant materials to be planted at the right location can alleviate future maintenance operations. For instance, the utilization of native or local trees is highly debated by the experts able to aid the cost reduction for maintenance due to higher chances of survival of these species that quickly adapt to the local climate and ecological setting. Besides utilizing native species, experts also accentuated that tree to be the main component of plant material used in public park design.

As part of the standard operational maintenance, other than a complete maintenance schedule, the experts highlight personal protective equipment (PPE) to successfully integrate workforce safety, linking to effective maintenance practice and cost-efficiency. Avoiding hazards and risks through PPE implementation can accelerate the maintenance routine and staff competency in handling the maintenance operation. In addition, experts also highlighted that for outsourcing landscape maintenance work, getting a reliable maintenance contractor with the significant background can connect experience and knowledge competency to effective operational maintenance. Furthermore, issues related to landscape waste are another significant highlight by the majority of the experts since tons of landscape waste are produced every single year. Hence, the effort by the Perbadanan Putrajaya and Gamuda Land initiative to decompose these organic waste materials as compostable items can support the green agenda and sustainability.

Particularly advanced technology has resulted in the innovation of new maintenance tools, equipment, and machinery to expedite the operation. Large municipalities example, Majlis Perbandaran Sepang (MPSepang) and Perbadanan Putrajaya (PPj), utilize the wood chipper machine to solve the landscape waste issue (example- waste from pruning activity like large branches) while at the same time encouraging and supporting the recycling practice. A significant duration of a landscape maintenance contract from two to three years (as currently being implemented by the Perbadanan Putrajaya) can encourage landscape contractors to invest in machinery, thus accelerating the maintenance activities and further supporting the national green agenda. Another critical highlight touches on the consistency of the landscape maintenance program, which also synergizes to effective operational maintenance associated with cost-efficiency.

## 6.2 RECOMMENDATION

### 6.2.1 The Sustainable Landscape Maintenance Checklist

Apart from the recommendation derived from this short duration study is the suggestion of the sustainable landscape maintenance checklist composed of criteria within the cycle of landscape development. This includes landscape planning and design development, construction and implementation, and the scheduled maintenance period. Considering these phases, ten landscape maintenance themes have been outlined for this checklist. With detailed analysis and discussion established in Chapters 4 and 5 of this report, this suggested maintenance checklist can generally guide landscape designers, contractors, and municipalities in producing a viable landscape design that is sustainable and maintenance-friendly.

Table 6.1 The Sustainable Landscape Maintenance Checklist

NO	CRITERIA FOR SUSTAINABLE LANDSCAPE MAINTENANCE
<b>1</b>	<b>Plant Strategically</b>
a.	Applying native and local species in landscape design.
b.	Landscape design should retain as much as possible the existing plants and vegetation.
c.	Applying the less-water consumption landscape design (Xeriscaping). <u>However, the application of this design should consider the area, location plot, and the suitable selection of plant materials.</u>
d.	Planting selection (in landscape design) should include various heights and habits to enhance the ecological value and biodiversity.
e.	Applying hydro zoning (group shrub planting) for effective water consumption.
f.	Trees to be the main component of plant's collection since it requires less maintenance in comparable to shrub and ground cover.
g.	Applying slow growing species in planting scheme for less maintenance.

h.	Plant selection should be based on the prevailing environment condition.
i.	Utilize the nitrogen-produced plants from Fabaceae or Leguminosae family especially for an unproductive soil (symbiosis approach-plants that can provide minerals to other plants).
j.	Applying rain garden or bioretention area.
k.	Applying bigger size planting holes for new planting and to the areas with low annual rainfall. The suggested planting hole size is between 2-3 sizes of the root ball.
l.	Consider to apply root barriers to control fast root development especially in urban landscape.
<b>2.</b>	<b>Fertilize Organically</b>
a.	Applying mix use of organic and chemical fertilizers to encourage plant growth.
<b>3</b>	<b>Soil and Composting</b>
a.	Recycling garden disposal materials to be used as mulching or organic fertilizers (cut grasses/grass clipping and dead leaves could be used for mulching. This helps to improve the soil texture and reduce the cost of disposal). <u>However, make sure that all compostable materials are decomposed and ‘ready’ before applying to the planting area.</u>
b.	Effective practice of mulching for retention of soil moisture. Suggested for compost mulching (include dried leaves, grass clipping, branches, crushed stone, shredded bark, sawdust, coconut mulch, etc.). <u>However, make sure that all compostable materials are decomposed and ‘ready’ before applying to the planting area.</u>
c.	Applying soil aeration (for rich, fertile and properly drain soil).
<b>4</b>	<b>Water Efficiently</b>
a.	Applying drip irrigation system to reduce overspray towards other plants or structure.
b.	Applying root watering system for high efficiency (enable water, oxygen, and nutrients to bypass compacted soil thus easily reach the tree root system).
c.	Creating irrigation zones for efficient watering system.
d.	Utilizing super absorbent polymer (SAP) for improving water use efficiency (growing gel for water retention). This additional water-holding material can be

	added in planting media as natural fibres and no-toxic gel (especially during initial plant growth).
e.	Practice rainwater harvesting for effective use of water source especially for watering the plants.
<b>5</b>	<b>Pruning and Shearing Strategically</b>
a.	Pruning is a long-term maintenance strategy and should be done by trained personals. Types of pruning may include structural pruning, crown cleaning, crown thinning, crown restoration, etc.
b.	Conducting tree risk assessment for tree safety management.
<b>6</b>	<b>Pest and Weed Control</b>
a.	Applying the Integrated Pest Management (IPM) for an effective and environmentally sensitive approach to pest management.
b.	Include the maintenance program for pest and disease control.
c.	Perform weeding and loosening the soil.
<b>7</b>	<b>Sustainable Hardscape Materials</b>
a.	Reuse of old building materials in new construction.
b.	Applying permeable paving (pervious concrete and asphalt) that easily allow filtration and flow of stormwater runoff.
c.	Use energy saving equipment such as solar energy lighting or solar water pump system.
d.	Use reclaimed materials as part of landscape design (reuse and recycle vegetation, rocks, and soil generated during construction).
e.	Use of local materials to promote sustainability while enhancing the local character of the place.
f.	Ensure quality of materials and workmanship (to enable all works on ground are according to design standards and specification).
<b>8</b>	<b>Minimizing Fuel Consumption</b>
a.	Choosing hybrid vehicles and alternative energy source for landscape maintenance tools and equipment.
b.	Choosing the best and shortest route/ distance to the site or maintenance plot.
<b>9</b>	<b>Sustainable Drainage System (SuDS)</b>

a.	Applying the sustainable drainage system (SuDS) for better surface management and control.
<b>10</b>	<b>Sustainable Tools and Equipment</b>
a.	Use advanced technology in maintenance such as woodchippers machines to solve the problem of large dumping ground space and support recycling practices.

## 6.2.2 Future Research Direction

### 6.2.2.1 Landscape Waste Management

The findings of this research have further paved to future research direction that potentially looks into recycling the park waste or, specifically, landscape waste management. This focus can cater environmentally and further contribute economically through waste management strategies. Even wood chippers and debris from the wood chipper machine can be reusable as mulching or other landscape applications.

### 6.2.2.2 Sustainable Landscape Design

Another potential area that could be expanded from this research is looking into sustainable landscape design. Since the majority of the experts acknowledge that maintenance consideration should begin as early as the planning and design development stage, hence the study focus should be drawn to the process of sustainable landscape design itself, enhancing the functionality and aesthetic landscape (with proper selection of plant materials and sustainable hardscape materials) that further result to minimal maintenance approach.

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# APPENDICES

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## APPENDIX 1

### Sustainable Landscape Maintenance for Malaysia's Public Park

This questionnaire is conducted to understand the sustainable landscape maintenance criteria for public park maintenance in Malaysia. You are invited to answer all questions in **PART A** and **PART B** of this questionnaire.

Please answer all questions in **PART A**

#### PART A: RESPONDENT BACKGROUND

1. Gender :  Male  Female
2. Age :  30 years and below  
 31-40 years  
 41-50 years  
 51-60 years
3. Profession :  Academics  
 Government Sectors  
 Local Authority  
 Landscape Consultant  
 Landscape Contractors  
 Nursery  
 Others
4. How long have you been involved in landscape industry?  
\_\_\_\_\_years

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Please answer all questions in **PART B**.

How much do you agree with these criteria to have an influence on public park maintenance in terms of practical operation and cost efficiency?

Please rank between 1 to 10 (1= **Strongly Disagree**; to 10= **Strongly Agree**).

#### PART B: THE CRITERIA FOR PUBLIC PARK MAINTENANCE

- |   | Strongly Disagree     | (1)                   | (2)                   | (3)                   | (4)                   | (5)                   | (6)                   | (7)                   | (8)                   | (9)                   | Strongly Agree        | (10)                  |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 1. Plant Strategically  |                       |                       |                       |                       |                       |                       |                       |                       |                       |                       |                       |                       |
| a. Applying native species in landscape design.   | <input type="radio"/> |
| b. Landscape design should retain as much as possible the existing plants and vegetation. | <input type="radio"/> |
| c. Applying the less-water consumption landscape design (Xeriscaping).                    | <input type="radio"/> |

- |  | Strongly Disagree     | (1)                   | (2)                   | (3)                   | (4)                   | (5)                   | (6)                   | (7)                   | (8)                   | (9)                   | Strongly Agree        | (10)                  |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| d. Planting selection (in landscape design) should include various heights and habits to enhance the ecological value and biodiversity.                                    | <input type="radio"/> |
| e. Applying hydro zoning (group shrub planting) for effective water consumption.   | <input type="radio"/> |
| f. Trees to be the main component of plant's collection since it requires less maintenance in comparable to shrub and ground cover.  | <input type="radio"/> |
| g. Applying slow growing species in planting scheme for less maintenance.  | <input type="radio"/> |
| h. Plant selection should be based on the prevailing environment condition.  | <input type="radio"/> |
| i. Utilize the nitrogen-produced plants from Leguminosae family especially for an unproductive soil (symbiosis approach-plants that can provide minerals to other plants). | <input type="radio"/> |
| j. Rain garden or bioretention area.   | <input type="radio"/> |
| k. Bigger size of planting holes for areas with low annual rainfall.   | <input type="radio"/> |
| l. Consider to apply root barriers to control fast root development especially in urban landscape.   | <input type="radio"/> |

## 2. Fertilize Organically

- |   | Strongly Disagree     | (1)                   | (2)                   | (3)                   | (4)                   | (5)                   | (6)                   | (7)                   | (8)                   | (9)                   | Strongly Agree        | (10)                  |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| a. Applying organic fertilizer instead of chemical fertilizers. | <input type="radio"/> |

## 3. Soil and Composting (Improving Soil Condition)

- |   | Strongly Disagree     | (1)                   | (2)                   | (3)                   | (4)                   | (5)                   | (6)                   | (7)                   | (8)                   | (9)                   | Strongly Agree        | (10)                  |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| a. Recycling garden disposal materials to be used as mulching or organic fertilizers (cut grasses/grass clipping and dead leaves could be used for mulching. This helps to improve the soil texture and reducing the cost of disposal). | <input type="radio"/> |
| b. Effective practice of mulching for retention of soil moisture. Compost mulching may include dried leaves, grass clipping, branches, crushed stone, shredded bark, sawdust, coconut mulch, etc.                                       | <input type="radio"/> |
| c. Soil aeration (for rich, fertile and properly drain soil).   | <input type="radio"/> |

#### 4. Water Efficiently

- |   | Strongly Disagree     | (1)                   | (2)                   | (3)                   | (4)                   | (5)                   | (6)                   | (7)                   | (8)                   | (9)                   | Strongly Agree        |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| a. Applying drip irrigation system to reduce overspray towards other plants or structure.   | <input type="radio"/> |
| b. Root watering system for high efficiency (enable water, oxygen, and nutrients to bypass compacted soil thus easily reach the tree root system).  | <input type="radio"/> |
| c. Creating irrigation zones for efficient watering system.   | <input type="radio"/> |
| d. Utilizing super absorbent polymer (SAP) for improving water use efficiency (growing gel for water retention). This additional water holding materials can be added in planting media- natural fibers and no-toxic gel (during the initial plant growth). | <input type="radio"/> |
| e. Rainwater harvesting for effective use of water source especially for watering the plants.   | <input type="radio"/> |

#### 5. Pruning and Shearing Strategically

- |  | Strongly Disagree     | (1)                   | (2)                   | (3)                   | (4)                   | (5)                   | (6)                   | (7)                   | (8)                   | (9)                   | Strongly Agree        |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| a. Pruning is a long-term maintenance strategy and should be done by trained personnel. Types of pruning may include structural pruning, crown cleaning, crown thinning, crown restoration, etc. | <input type="radio"/> |
| b. Conducting tree risk assessment for tree safety management.   | <input type="radio"/> |

#### 6. Pest and Weed Control

- |  | Strongly Disagree     | (1)                   | (2)                   | (3)                   | (4)                   | (5)                   | (6)                   | (7)                   | (8)                   | (9)                   | Strongly Agree        |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| a. Applying the Integrated Pest Management (IPM) for an effective and environmentally sensitive approach to pest management. | <input type="radio"/> |
| b. Pest and disease control.   | <input type="radio"/> |
| c. Weeding and loosening the soil.   | <input type="radio"/> |

#### 7. Sustainable Hardscape Materials

- |  | Strongly Disagree     | (1)                   | (2)                   | (3)                   | (4)                   | (5)                   | (6)                   | (7)                   | (8)                   | (9)                   | Strongly Agree        |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| a. Reuse of old building materials in new construction.  | <input type="radio"/> |
| b. Applying permeable paving (pervious concrete and asphalt) that easily allow filtration and flow of stormwater runoff. | <input type="radio"/> |
| c. Use energy saving equipment such as solar energy lighting or solar water pump system.                                 | <input type="radio"/> |
| d. Use reclaimed materials as part of landscape design (reuse and recycle  | <input type="radio"/> |

- vegetation, rocks, and soil generated during construction).
- e. Use of local materials may promote sustainability and enhance the local character of the place.
- f. Quality of materials and workmanship (to ensure that all works on ground are according to design standards and specification)

Strongly Disagree (1) (2) (3) (4) (5) (6) (7) (8) (9) Strongly Agree (10)

8. Minimizing Fuel Consumption

- a. Choosing hybrid vehicles and alternative energy source for landscape maintenance tools and equipments.

Strongly Disagree (1) (2) (3) (4) (5) (6) (7) (8) (9) Strongly Agree (10)

9. Sustainable Drainage System (SuDS)

- a. Applying the sustainable drainage system (SuDS) for better environment beneficial.

Strongly Disagree (1) (2) (3) (4) (5) (6) (7) (8) (9) Strongly Agree (10)

10. Sustainable tools and Equipment

- a. Use advance technology in maintenance such as wood chippers machine which may solve the problem of large dumping ground space and aid in recycling practices.

Strongly Disagree (1) (2) (3) (4) (5) (6) (7) (8) (9) Strongly Agree (10)

11. Other (Please state any)

- i. \_\_\_\_\_  
 \_\_\_\_\_
- ii. \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Thank you for participating in this survey.

## APPENDIX II

## EVALUATION OF THE COST IMPLICATION ON PUBLIC PARK MAINTENANCE

Soal selidik ini dijalankan untuk memahami kriteria penyelenggaraan landskap lestari untuk penyelenggaraan taman awam di Malaysia. Anda dijemput untuk menjawab semua soalan di **BAHAGIAN A**, **BAHAGIAN B** dan **BAHAGIAN C** soal selidik ini.

### BAHAGIAN A: LATARBELAKANG RESPONDEN

1. Nama : \_\_\_\_\_
2. Jawatan : \_\_\_\_\_
3. Profession :  Academics  
 Government Sectors  
 Local Authority  
 Landscape Consultant  
 Landscape Contractors  
 Developer  
 Others
4. Berapa lama anda telah praktis di dalam industri landskap?  
 \_\_\_\_\_

### BAHAGIAN B: OPERASI PENYELENGGARAAN LANDSKAP YANG EFEKTIF DAN IMPLIKASINYA TERHADAP KOS

1. What is your view to a statement saying 'parks without maintenance is a waste'?  
 Apa pandangan anda terhadap pernyataan yang mengatakan 'parks without maintenance is a waste'?  
 \_\_\_\_\_  
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 \_\_\_\_\_
2. To maintain a park, need an appropriate procedure and systematic planning, what are key component on an appropriate procedure and systematic planning in park maintenance?

Penyelenggaraan taman memerlukan prosedur dan perancangan yang sistematik, apakah komponen serta prosedur yang sesuai dan perancangan sistematik dalam penyelenggaraan taman?

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3. What is your opinion in regards to standard operational maintenance to cost efficiency?

Apa pendapat anda mengenai operasi 'standard' penyelenggaraan dan implikasinya terhadap kos operasi penyelenggaraan landskap?

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4. From your opinion, what are the effective operational maintenance practice that able to result to cost efficiency?

Pada pendapat anda, apakah amalan penyelenggaraan landskap yang efektif yang boleh mengurangkan kos operasi penyelenggaraan landskap?

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## BAHAGIAN C: KRITERIA UNTUK PENYELENGGARAAN TAMAN AWAM

How much do you agree with these criteria to have an influence on public park maintenance in terms of practical operation and cost efficiency? You are required to state your answer- AGREE or DISAGREE to these statements (these statements are derived from the literature review and pilot survey and all themes and parameters were established through these exercises).

### 1. Plant Strategically

#### Penanaman secara strategik

- a. Applying native species in landscape design.
- b. Landscape design should retain as much as possible the existing plants and vegetation.
- c. Applying the less-water consumption landscape design (Xeriscaping).
- d. Planting selection (in landscape design) should include various heights and habits to enhance the ecological value and biodiversity.
- e. Applying hydro zoning (group shrub planting) for effective water consumption.
- f. Trees to be the main component of plant's collection since it requires less maintenance in comparable to shrub and ground cover.
- g. Applying slow growing species in planting scheme for less maintenance.
- h. Plant selection should be based on the prevailing environment condition.
- i. Utilize the nitrogen-produced plants from Leguminosae family especially for an unproductive soil (symbiosis approach-plants that can provide minerals to other plants).
- j. Applying rain garden or bioretention area.
- k. Applying bigger size of planting holes for areas with low annual rainfall.
- l. Consider to apply root barriers to control fast root development especially in urban landscape.

### 2. Fertilize Organically

#### Penggunaan Baja Organik

- a. Applying organic fertilizer instead of chemical fertilizers.

### 3. Soil and Composting (Improving Soil Condition)

#### Tanah dan Kompos (Memperbaiki Keadaan Tanah)

- a. Recycling garden disposal materials to be used as mulching or organic fertilizers (cut grasses/grass clipping and dead leaves could be used for mulching. This helps to improve the soil texture and reducing the cost of disposal).

- b. Effective practice of mulching for retention of soil moisture. Compost mulching may include dried leaves, grass clipping, branches, crushed stone, shredded bark, sawdust, coconut mulch, etc.
- c. Applying soil aeration (for rich, fertile and properly drain soil).

#### **4. Water Efficiency**

##### **Pengairan yang efektif**

- a. Applying drip irrigation system to reduce overspray towards other plants or structure.
- b. Applying root watering system for high efficiency (enable water, oxygen, and nutrients to bypass compacted soil thus easily reach the tree root system).
- c. Creating irrigation zones for efficient watering system.
- d. Utilizing super absorbent polymer (SAP) for improving water use efficiency (growing gel for water retention). This additional water holding materials can be added in planting media- natural fibers and no-toxic gel (during the initial plant growth).
- e. Practice rainwater harvesting for effective use of water source especially for watering the plants.

#### **5. Pruning and Shearing Strategically**

##### **Pemangkasan dan Pematangan Secara Strategik**

- a. Pruning is a long-term maintenance strategy and should be done by trained personals. Types of pruning may include structural pruning, crown cleaning, crown thinning, crown restoration, etc.
- b. Conducting tree risk assessment for tree safety management.

#### **6. Pest and Weed Control**

##### **Kawalan Perosak dan Rumpai**

- a. Applying the Integrated Pest Management (IPM) for an effective and environmentally sensitive approach to pest management.
- b. Include in the maintenance program for pest and disease control.
- c. Perform weeding and loosening the soil.

**7. Sustainable Hardscape Materials**

**Landskap Kejur yang lestari**

- a. Reuse of old building materials in new construction.
- b. Applying permeable paving (pervious concrete and asphalt) that easily allow filtration and flow of stormwater runoff.
- c. Use energy saving equipment such as solar energy lighting or solar water pump system.
- d. Use reclaimed materials as part of landscape design (reuse and recycle vegetation, rocks, and soil generated during construction).
- e. Use of local materials may promote sustainability and enhance the local character of the place.
- f. Ensure quality of materials and workmanship (to enable all works on ground are according to design standards and specification).

**8. Minimizing Fuel Consumption**

**Meminimumkan Penggunaan Bahan Bakar**

- a. Choosing hybrid vehicles and alternative energy source for landscape maintenance tools and equipments.
- b. Choosing the best and shortest route / distance to the site or maintenance plot.

**9. Sustainable Drainage System (SuDS)**

**Sistem Saliran Lestari (SuDS)**

- a. Applying the sustainable drainage system (SuDS) for a better surface (water) management and control.

**10. Sustainable tools and Equipment**

**Penggunaan Peralatan dan Mesin yang Lestari**

- a. Use advance technology in maintenance such as woodchippers machine to solve the problem of large dumping ground space and support in recycling practices.
- b. Others (to explain)

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