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Conceptual Framework of Landscape Physical Quality Assessment: A Review of Challenges and Paradigms for the Malaysian Construction Industry

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ABSTRACT

Workmanship quality is becoming an increasingly important issue in construction project management, sparking tons of new debates. In a more profound aspect, practitioners consider landscape quality to be oversimplified in its quality assessment. Various rating tools were introduced, but critics argued that a high-quality landscape had already been achieved. Despite the fact that existing rating tools indicated that the themes and elements accessed already had a landscape component, only a few minor aspects were evaluated. Given the diversity of the landscape as well as the political and management systems, experts in the field are unable to identify a single type of tool that is universally applicable to quantifying the overall quality of a landscape construction project. The main question which remains to be answered is, "what constitutes the landscape physical quality assessment?". This article aims to provide a concise review of the process theory for measuring criteria related to the assessment of landscape physical quality to address the research question. The review is based on the theoretical background and concepts of the relevant study taken from various established database references on "landscape quality", "landscape assessment", and "landscape evaluation". Multilayered thematic analysis was carried out to identify the landscape physical quality assessment indicator. In accordance with the metadata findings, landscape quality assessment should have been evaluated using five key categories: 1) perceived character and significant values; 2) perception, preferences, and satisfaction; 3) landscape visual and aesthetic; 4) environmental condition, sensitivity, and trend; and 5) construction, functional, and performance quality. This study implies that the landscape physical quality assessment was generic, regardless of landscape project type, which could then efficiently steer industry players in conducting standard quality checks and preparing big data for landscape construction projects.

1.0 INTRODUCTION

The problem of industry perception lies within the misleading construction project management understanding that landscape is merely a "cosmetic element" in the built environment (Pillay, 2017). This continuing argument and misunderstanding have led towards a degradation of the workmanship quality for landscape elements through Quality Assessment System in Construction (QLASSIC) assessment (CIDB, 2015; Tahir, 2021), especially for the past 20 years, which reflects the design quality too (Critirion Planner, 2014; Othman, 2020; SIRIM, 2021). However, this QLASSIC assessment system only reflects the physical workmanship of tangible elements in building projects, while landscape content (intangible) criteria for memory, history, experience, visual quality, senses and placeness have yet to be identified and practised in the quality rating system in the industry. The actual challenges faced by the Malaysian Landscape Construction project is when the non-building project was determined to be assessed by key indicator measures for a building assessment tool. Therefore, in achieving better landscape design and construction, which complement the Sustainable Development Goal (SDG), there is a significant relationship between landscape content and landscape construction workmanship factors to be studied to deliver and experience a higher landscape physical quality. Landscape design and construction, which adapted design content (memory, experience, visual quality, senses and placeness) and construction workmanship (material, construction method, labour) in a given landscape context are likely to have higher Landscape Physical Quality.

The landscape industry within the built environment supports the environmental, social, and economic foundations of sustainability, addressing the requirements of both humanity and the ecosystem. For example, thrust 3 of the National Landscape Policy (JLN 2011) action plans, Strategy 3.2 "Encourage Manageable and Sustainable Landscape Development Programmes in Order to Achieve Beautiful Garden Nation" has become the main aim for each project development which targeting into achieving a beautiful yet sustainable living environment for the community. Equivalently, it is supported by a statement from Former Prime Minister Tun Dr Mahathir Mohamad in 2019, which "Malaysia's path to fully developed status requires a sustainable physical plan that puts the environment first over profit". This highlights the need for effective initiative in sustaining a landscape and environmental quality, despite emerging markets' desire to earn profit and meet current needs. The simplest way in achieving quality of life is highlighted through the understanding of a "better surrounding and quality living environment" concept and objectives (Aziz, 2022). However, how do we define "better surroundings and quality living environment " in such a diversified and extensive landscape? The question of scale has made landscape to be quantitatively and qualitatively challenging to evaluate (Davoudi & Brooks, 2019). In response, it is essential to comprehend the term "landscape" in a broader context, beyond mere decorative and aesthetic functions as mentioned by Pillay (2017). This is because landscape is more than what constitutes human perspectives and perceptions (Hisschemöller et al., 2022); it is also a strategy for sustaining the quality of the environment. Therefore, it is important to identify and understand a holistic landscape physical quality assessment to provide a high-quality landscape design and construction workmanship with strategic protection, preservation and conservation factors in achieving better development in Malaysia.

2.0 LITERATURE REVIEW

There is a broad body of academic resources and understanding towards the landscape definition, history of landscape quality and the approaches to quantify the quality aspects. It ranges from more fragmented and static to more holistic, dynamic and multisensory involvements in evaluating the specific 'landscape value and quality'. The European Landscape Convention (ELC) defines landscape in article 1 as "an area as perceived by people, whose character is the result of the action and interaction of natural and human factors" (Ahern & Cole, 2009; Council of Europe, 2006; Hisschemöller et al., 2022). The spatial scale of the landscape inquiry is between the ecosystem and the region, with difficult-to-define boundaries, and it is the broad strings that are most closely related to humans (Song et al., 2022). This also expands with the meaning of landscapes described and highlighted in the following citation:

> *Landscape is a result from the way that different components of our environment - both natural (the influences of geology, soils, climate, flora and fauna) and cultural (the historical and current impact of land use, settlement, enclosure and other human interventions) - interact together and are perceived by us. People's perceptions turn land into the concept of landscape (Swanwick and Land Use Consultants, 2002; Swanwick et al., 2007 cited in Davoudi & Brooks, 2019)*

Landscape Architects plan, design and manage natural and built environments, applying aesthetic and scientific principles to address ecological sustainability, quality and health of landscapes, collective memory, heritage and culture, and territorial justice. By leading and coordinating other disciplines, landscape architects deal with the interactions between natural and cultural ecosystems, such as adaptation and mitigation related to climate change and the stability of ecosystems, socio-economic improvements, and community health and welfare to create places that anticipate social and economic well-being (IFLA, 2022).

Landscape is a multi-dimensional scope of study that is difficult to evaluate in most aspects and has never been adequate for recognizing the limits. Landscape quality is not only determined to preserve landscape ecological patterns, but also known for their contribution to people's quality of life (Wartmann, Stride, et al., 2021). However, development growth and population demands of built structures/construction development, recently, has often been viewed and described as human material encroachment, associated with negative impacts on perception of landscape quality; or categorized as 'disturbance' towards natural ecosystems (Davoudi & Brooks, 2019). Human disturbance was believed to have a more significant impact on landscape quality than natural factors. Although the significance of evaluating the contributions of nature and landscapes to human well-being is increasingly acknowledged through frameworks like ecosystem services (Wartmann et al., 2021), however, the landscape construction quality assessment has comparatively underdeveloped (Swetnam & Tweed, 2018; Kamal et al., 2021). Various environmental rating tools have reduced landscape as few elements into just landscape planting, pedestrian walkway or plaza in specific design criteria (Critirion Planner, 2014; SIRIM, 2021) which allowing a huge gap in measuring of what constitute a high-quality physical landscape outside of building and infrastructure project at larger scale of a non-building construction project.

The implementation ideas of the ELC landscape policies, the UK Landscape Character Assessment (LCA) framework and few other sources of landscape assessment scholar's research and rating tools has at its center a hierarchical classification system to quantify the quality in landscape. Each typology, framework and theory applied has pinpointing a varied landscape quality objective and indicator to be used in landscape planning and management for construction and development approach (Lothian, 1999; Daniel, 2001; Wartmann, Frick, et al., 2021). Despite this difficulty, to date, more researchers have highlighted as much as possible related indicators for the landscape quality evaluation. This effort has underlined both the value of people's engagement and experience of landscape, aesthetic appreciations and also landscape quality evaluation that is easily overlooked in detailed and inventorial techniques to monitoring the natural environment and the construction elements (Windhager et al., 2010; Battis-Schinker et al., 2021; Huang et al., 2022). Measuring landscape quality through aesthetics and strict construction quality conformance and control could be thought of as a tough perceptual approach to this challenge. Similar to a long-running argument in aesthetics philosophy, the history of landscape quality assessment has seen a conflict between expert/design approach and perception-based approaches (Sahraoui et al., 2021; Spielhofer et al., 2021; Wartmann, Frick, et al., 2021). Perhaps, it is essential to understand how alterations in landscape composition transfer to the visible landscape; towards the sense of landscape connection, sustainability and identity, and how this influences public perception (San Martin Saldias & McGlade, 2022).

For decades, numerous methods for assessing landscape values have emerged. According to Lothian (1999), the objectivist (or physical) paradigm and the subjectivist (or psychological) paradigm are the two ways to evaluate landscapes. A third way, called the "convergent approach," is being created by combining the ideas of both experts and the public (Mundher et al., 2022). In these concerns, public perspectives and judgement were based on overall basis; single and multiple aspects. For example, each landscape element/certain structure may collect a long-term memory for an individual, however, the whole landscape subject/narratives that contain multiple elements bring an experience that creates the whole story which won't be forgotten by the people. That is how important the landscape environment is for the people. It is not the matter of seeing it but how we perceive it.

2.1. Challenges and Issues Confronting the Industry

According to the literature study (Figure 1), these problems emanated from the problem of industry perception, ill referred and lack of standards towards landscape design and construction workmanship measurement process. First and foremost, various environmental rating tools have reduced landscape as few elements into just vegetation, pedestrian walkway or plaza in specific design criteria or carbon calculation method (Critirion Planner, 2014, SIRIM, 2021). This is due to the perception of industry players which see

landscape architecture in only building construction project management scope (Othman, 2020). This could be entailed from the classification of construction projects by the Ministry of Public Work where construction projects involved mainly building and infrastructure work (JKR, 2015). Because of the misleading understanding, there is a huge gap in measuring of what constitute a quality physical landscape outside of building and infrastructure project at larger scale such as park, swamp, hill and forest, beach, waterfront and waterfall - a non-building construction project with a dedicated field of economic - ecological economic (Heide and Heijman, 2013).

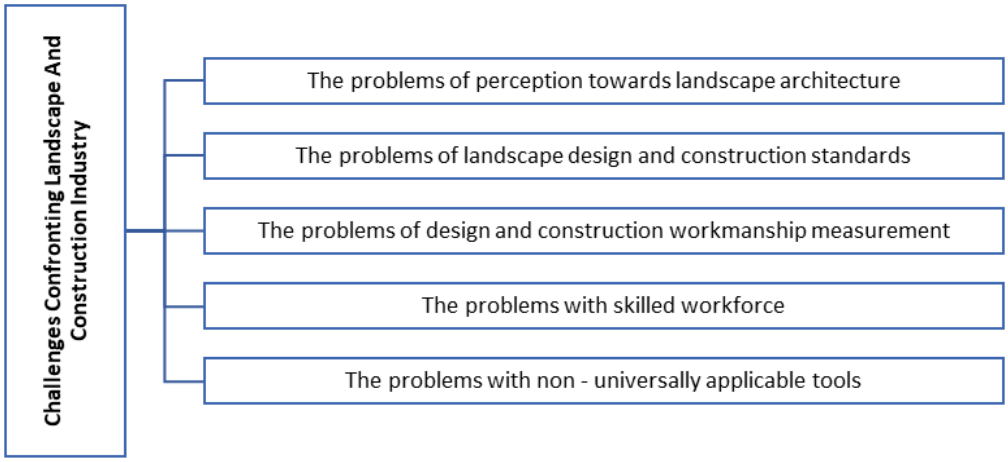

Figure 1. Five significant challenges confronting landscape and construction industry. Source: Author (2024).

Secondly, linking the perceptive problem of what quality physical landscape constitutes, the quality of landscape construction for the last decade particularly in government projects were measured to be below par due to the problem of ill referred to the establishedstandards and quality measurement system. Over the last 15 years, landscape construction quality in Malaysia has been highly argued (CIDB, 2015) while using the QLASSIC assessment system that is also long overdue to be reviewed. Ranging from various scales of green spaces in the construction project, softscape and hardscape elements continued to show lack of workmanship quality and were subject to be scrutinized during site visit and final inspection among local authorities and project team members (Othman, 2020). These are compounded by the national landscape construction competency which has yet to complete up until level 5 of Certified Construction Manager and needs a review (CIDB, 2015). As minimum as 10 percent or more of total area allocated for green space also known as landscape area, the area has influenced the effectiveness of cost control of the project even after the project is completed (CIDB, 2015). This problem originated from ill referred standards and guidelines for landscape elements which have not been addressed properly and influenced landscape design, construction and operation.

Thirdly, continuing to the problem of ill referred standards, the landscape design and construction workmanship measurement arise. The current training provision for landscape construction is reduced of its session frequency and the landscape contractors were placed together with building contractors during the training held (Othman, 2020). As a result, the landscape contractor training provision is skewed toward building construction projects while landscape design elements continue to be reduced into just a few elements. This training strategy is sound for economic efficiency, but it impedes the competency of landscape contractors in the long term, hence the competency for landscape contractors to complement the design acquired from landscape architects especially in non-building construction projects. In landscape design development, guide and measurement of intangible quality are obscure to rebuilt and retain the originality of landscape narrative especially in non-building construction project in order to retain and conserve the content of the place such as memory, experience, visual quality, senses and placeness to be captured and represent a certain local cultural landscape. Thus, this has led to the landscape elements design and workmanship assessment at some different points being marginalized. Landscape architect, quality manager, assessor and facilitator at the earlier stage see landscape element does not have documented standard measurement process and tools to indicate the quality of design and constructed elements.

Following that, this ongoing issue pinpoints the problems with the skilled workforce. According to Musa et al., (2018), the case in Malaysian Construction industry is not in line with the target future development of Malaysia in which a shortage of skilled workers in the landscape industry has resulted in substandard construction practices and craftsmanship. The Construction Industry Development Board (CIDB) has defined that this is due to the lack of quality, productivity, safety and excessive reliance on unskilled workers which is 69% (552,000) out of total 800,000 of registered workers as in June 2007 were foreign workers (CIDB, 2008). The majority of those who come to work in Malaysia are thought to lack the basic skills required for construction work, which has had an impact on productivity and quality in our industry. The Malaysian construction industry is constantly striving to revamp and modernize due to some frequent issues raised by clients and stakeholders in Malaysia who expressed their concern regarding poor performance by contractors.

There are various well-known applications of rating tools that have been developed to assess the sustainability, performance, and quality of a built environment project such as SITES, LEED, CONQUAS, Sustainable Landscape Rating Tools and Malaysian developed tools; GBI, GreenRE and QLASSIC. Given the diversity of sustainable rating tools, however, the assessment of landscape elements is too limited, as if landscape is only a minor impactful element in each massive project; in other words, we are unable to recognize any tools or systems that are universally applicable with particular attention to a landscape project (Council of Europe, 2006). As a result, incorporating landscape considerations into policies for all sectors that directly or indirectly affect the landscape is critical. Researchers and scholars have struggled to highlight the need for a comprehensive and extensive analysis of landscape components and their interrelationships, and multiple types of indicators' ability and effectiveness paradigms have recently been identified to analyse landscapes.

2.2. Evolution of Landscape Quality Assessment

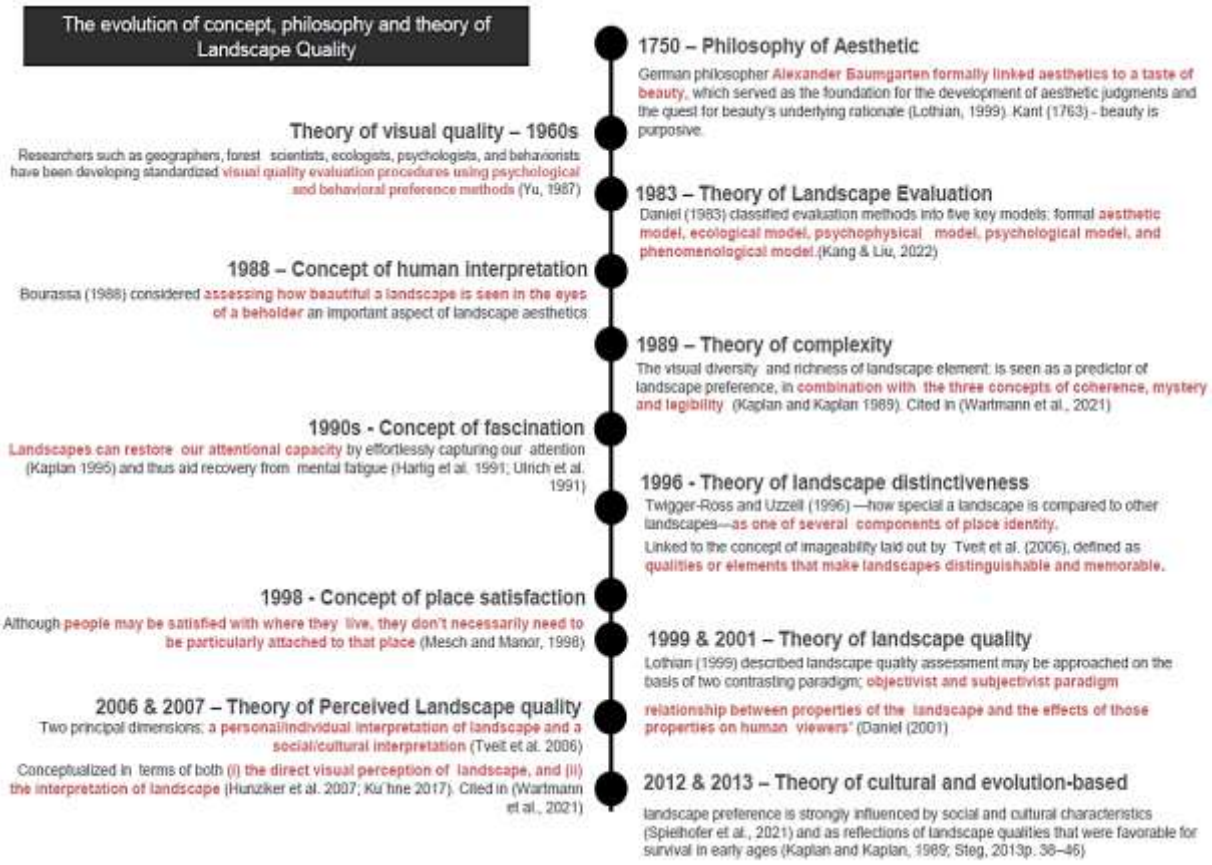

Figure 2. Evolution of Landscape Quality study

From the above literature, it can be seen that the scholar and most of the researchers around the world had studied management, planning and also sustainability in order to maintain the landscape quality from various aspects, and varied from assessment to application methods. There is still an unsolved problem especially in the selection of assessment indicators which are also related to the context variables and also the limitation scales of the study; most studies commonly prefer focusing on specific scope and context (refer Figure 2).

Hence finally this issue had put limitations in landscape quality assessment and created confusion for trained landscape contractors to assess thus resulted in competency argumentation. Therefore, by listing out every scope of study in landscape and related indicators for assessment play a critical role in strengthening the planning aspect especially for regulatory measures of construction management and environmental protection policies. Qualitative assessment methods and simple assessment models are too often being used in the traditional landscape quality assessment (Han et al., 2021), which selected indicator assessment is relatively small scales and place/scope specific criteria, lack of innovation and effectiveness of selected model that has made 'landscape quality' is a questionable and complex problems to be solved.

The objectives of landscape evaluation are generally noticeable, however, developing a practical method to achieve them remains a challenge. Even though the values of landscape quality are widely recognized in every factor as a critical discipline to understand in development and planning, there are too few studies on how the whole range of landscape quality should be assessed as a whole comprehensive assessment. This paper aims to fill this gap by exploring the variables and key factor aspects to determine high quality physical landscape based on multiple measuring criteria in landscape architectural studies. The reliability and effectiveness of so-called high-quality landscapes which are solely based on the proportion of image elements in landscape assessment remains unclear. Therefore, this study fulfills the gaps by demonstrating the correlations between the physical characteristics of landscape elements and contents which resulted in landscape aesthetic satisfaction and quality value.

3.0 RESEARCH METHODOLOGY

This section aimed to examine the conceptual foundation of studies assessing the physical quality of landscapes. The main objective of this research is to identify the process theory of measuring criteria for landscape quality which constitute; landscape content (design quality) and construction workmanship (construction quality). This research uses a conceptual framework approach which is defined as a methodology wherein research is conducted by observing and analysing already present information on a given topic (Roy et al., 2012; Bhat, 2018; Mundher et al., 2022). Pragmatic study was employed in order to evaluate the effectiveness of interventions in industry practice and condition while focusing on correlations between theoretical study and the implementation of the assessment framework in real landscape construction projects. By interpreting the existing concepts, ideas, philosophies and theories from multiple resources databases, this research has brought a concept of landscape physical quality in a different light. This research adopts a qualitative approach by using Atlas.ti software (Zairul, 2020), in defining the appropriate themes for this research study. An initial literature review was conducted using multiple databases such as Science Direct, Research Gate, and Scopus journal list and the topic distribution were found by searching filtering keywords of "landscape quality", "landscape assessment" and "landscape quality evaluation". The themes were interpreted and mapped using a multilayered thematic analysis approach. The analysis framework comprises diving into the relationship between the categories and the theme based on networks of co-cited documents.

Figure 3. Flow of research study.
Sources: Adapted from Noor et al., (2021) & Salih et al., (2023)

3.1. Search Strategy

The inclusion criteria include the review on research papers of 5 relevant years (2018 – 2024) and language of the studies; English language. Studies published before 2018, languages other than English and review papers were excluded (as in Figure 4). Landscape quality study is a broad research study which has been presented since then, however, due to recent global development changes and issues, this paper focused on 5 recent years in order to gain more comprehensive and new findings. Thus, the keywords applied in this study and search strategy is also to redirect this research towards narrower subjects as visualized in detail on Figure

3. The focus of this study is to identify methods of evaluation and assessment variables in determining high-quality landscape.

3.2. Search Outcome

A total of 116 research paper are identified from the three electronic database and manual search using text material such as google scholar of other sources and references (n = 16) as shown in Figure 4. After extracting which include both inclusion and exclusion criteria, a total of 40 studies remained. All these 44 metadata were transferred to Atlas.ti 23 as a primary document. In the first round of coding, 44 initial codes were produced before the codes were grouped into several code group (themes) to answer the research question which contributed to a final of 2 main categories of scope analysis study. The findings of these metadata will be divided into 2 parts: Quantitative findings and qualitative findings.

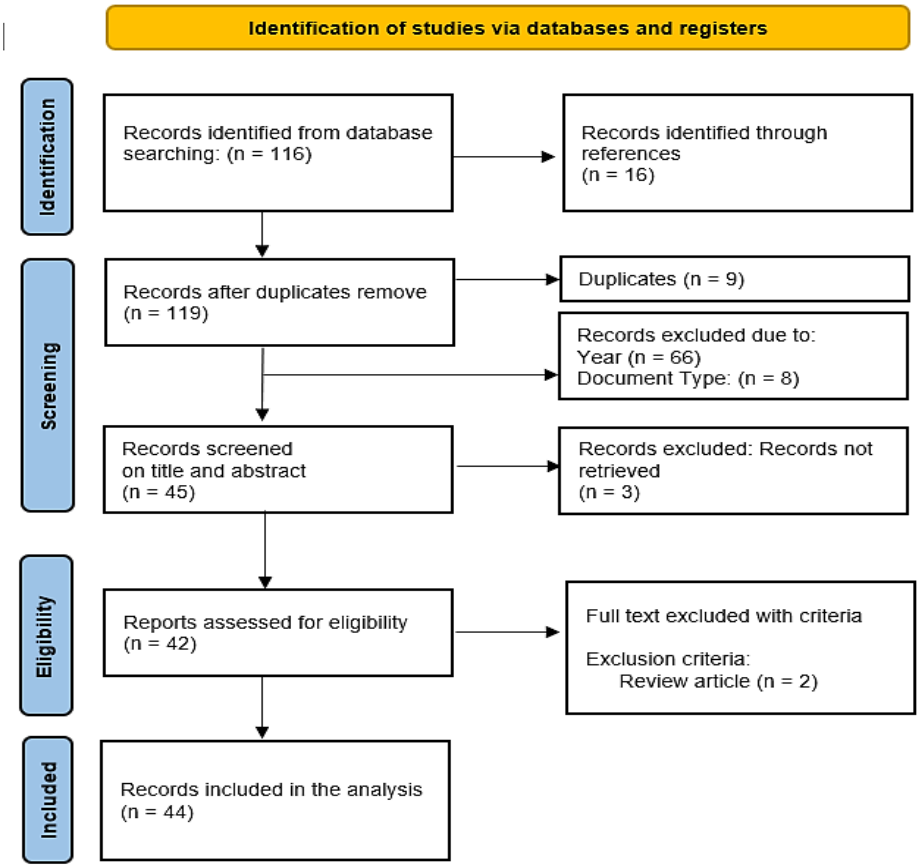

Figure 4. Studies selection flowchart based on PRISMA diagram.

4.0 FINDINGS

According to the study in multiple databases, the trends and patterns found in the landscape quality study were published in a wide range of journals. These research strings appear not only in the science of the built environment and landscape studies but also in geography and engineering.

4.1. Quantitative Findings – A Systematic study on Landscape Quality Assessment Theme

Table 1 shows that the trends in publishing articles related to landscape quality studies are increasing and vary in scope year after year. The spike in the number of published articles in 2021 could be attributed to the post-COVID period, in which many scholars' ideas and articles have yet to be composed as a result of the pandemic in 2020. Meanwhile, the distribution of articles by year and continent provides an overview of a country's interest in and awareness of landscape quality studies. Figure 5 reveals that European and Asian countries produce a large number of journal articles every year. Cultural and national identity may cause these two continents to be more likely to extend their studies in order to deepen their understanding of the aspects and factors involved in protecting and maintaining their valuable assets, specifically their cultural, historical, and natural assets. China, Indonesia, and European countries, in particular, place a high value on the landscape

quality assessment study such as; conservation, protection, preservation, and sustainability, resulting in a wide range of study findings that are used and cited all over the world.

Table 1. Publication found according to journal and year.

Journal	Year							Total
	2018	2019	2020	2021	2022	2023	2024	
Alam Cipta				1				1
Applied Geography		1						1
Architecture and Urban Planning			1					1
Automation in Construction					1			1
BIODIVERSITAS			1					1
Computers, Environment and Urban Systems	1							1
Ecological Indicators				2		2	1	5
Environmental Development					1			1
Environmental Sciences							1	1
Environmental Science and Policy				1				1
European Journal of Environmental Sciences			1					1
European Journal of Sustainable Development	1							1
Frontiers in Ecology and Evolution					1			1
Frontiers of Architectural Research				1				1
International Journal of Mining, Reclamation and Environment			1					1
Journal of Digital Landscape Architecture				1				1
Journal of Environmental Management				1				1
Journal of Environmental Psychology	1							1
Journal of Outdoor Recreation and Tourism			1					1
Landscape Ecology							1	1
Land Use Policy	2	1						3
Landscape and Urban Planning		1	2	1	2			6
MDPI Journals				2		3	1	6
Ocean and Coastal Management						1		1
Public Library of Science - PLOS ONE Journal						1		1
Urban Climate					1			1
Urban Forestry & Urban Greening				1		1		2
Total								44

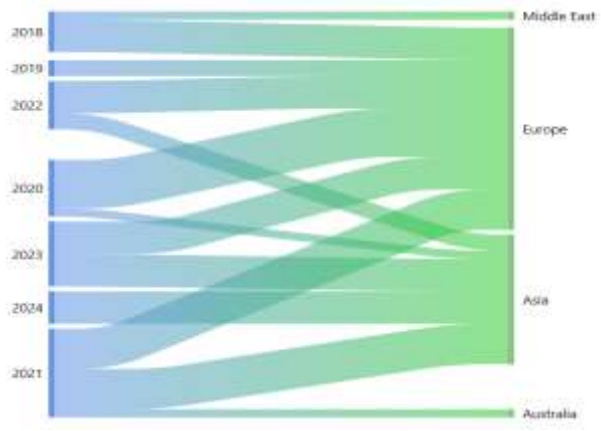

Figure 5. Distribution of articles according to publication year and continents.

After transferring all 40 metadata into Atlas.ti as the primary document, theme sorting becomes more accessible and more systematic. While screening all of the metadata, 44 codes were initially coded and tagged, and one code group, ‘measuring criteria', was created. The selected codes that based on the suitability of the quotations were then used to categorize it into five main themes: 1) construction, functionality, and performance assessment; 2) landscape condition, sensitivity, and trends assessment; 3) landscape visual and aesthetic assessment; 4) perceived character and significant value assessment; and 5) perceptions, preferences, and satisfaction assessment as shown in Table 2.

Table 2. Document to a theme table.

Document	Themes				
	Construction, Functionality and Performance Assessment	Landscape condition, sensitivity and trends Assessment	Landscape Visual and Aesthetic Assessment	Perceived Character and Significant Value Assessment	Perceptions, Preferences and Satisfaction Assessment
(Barchia et al., 2020)		/		/	
(Hu et al., 2023)		/			
(Jie Zhang et al., 2023)		/			
(Jingxiao Zhang et al., 2023)		/			
(Keleş et al., 2018)			/		
(Kostanjšek & Golobič 2023)	/	/			
(Noor et al., 2021)	/		/		
(Stauskis 2020)		/		/	
(Yang 2023)	/	/			
(Zhang et al., 2022)			/		
(Gobster et al., 2019)			/		
(Chang Chien et al., 2021)			/		
(Fernández-Alvarado & Fernández-Rodríguez, 2022)	/	/			
(Jridi et al., 2023)		/		/	
(Legwaila et al., 2020)			/		
(Rędzińska & Szulczewska, 2019)	/			/	/
(Roth et al., 2021)		/		/	
(Shahamati, 2020)					/
(Stemmer, Kausen, et al., 2021)			/	/	
(Brunetta et al., 2018)		/		/	
(Burgui-Burgui et al., 2022)	/				
(Chmielewski et al., 2018)			/		/
(Clarke et al., 2021)		/		/	
(Cottet et al., 2018)			/		
(Gobster et al., 2020)			/		
(Gobster, Rigolon, et al., 2020)	/				
(Han et al., 2021)		/		/	
(Jahani et al., 2021)					/
(Jin & Wang, 2021)			/		/
(Kalinauskas et al., 2021)	/	/			
(Kirchhoff et al., 2022)	/				
(Li et al., 2021)					
(Merry et al., 2020)					
(Olszewska-Guizzo et al., 2023)	/	/			
(Solecka et al., 2022)			/	/	/
(Swetnam & Korenko, 2019)	/				
(Swetnam & Tweed, 2018)			/		
(Wan et al., 2022)	/		/		
(Wartmann et al., 2021)			/		/
(Williams et al., 2023)	/				
(Zhou et al., 2024)		/	/	/	
(Xi et al., 2024)	/	/			
(Kim & Son, 2024)			/		/
(Sahragard et al., 2024)		/	/		

Depending on the trends and patterns of the research topic from year to year, Table 2 shows that the interest in studies in landscape quality five years ago (2018, 2019, and 2021) was more towards social studies that define the user's perceptions, preferences, and satisfaction with their surrounding landscape. In contrast, in the last three years, scholars and researchers have begun to broaden and deepen the scope of study to include more technical topics that have a more tangible impact and effect on the surrounding environment. Meanwhile, the most consistent areas of interest in landscape quality research are visual and aesthetic assessments, which have demonstrated that beauty in landscapes is primarily measured by user interest dominantly by artistic endeavours, innovation, naturalness and trends (Swetnam & Tweed, (2018); Gobster et al., (2019); Legwaila et al., (2020).

4.2. Qualitative Findings - The Importance of Multiple Indicator/Variables as A Tool for Assessment Process

With the help of the Atlas.ti software, this study generated a word cloud (Figure 6) depicting a co-occurrence keyword for measuring criteria in landscape quality assessment. This analysis has notably highlighted key indicators and elements that should be included in a framework used to evaluate a landscape project such as; aesthetic, perceived, functionality, safety and many more. According to the analysis, landscape quality assessment encompasses a variety of tangible and intangible aspects that influence the overall quality of a landscape project that is carried out. Similarly, to the planning and maintenance aspects, each sub-element is important and must be thoroughly evaluated to ensure the longevity of the landscape area. Each sub-element assessed employing the appropriate method and paradigm is expected to determine a high-quality, long-term impact on a landscape area, depending on its extent.

Figure 6. Word cloud showing keyword co-occurrence analysis for measuring criteria.

4.2.1. Perceptions, preferences and satisfaction assessment

Humans are users with expectations, preferences, and satisfaction that must be fulfilled. As permanent residents, the local population has unique interests and perspectives shaped by local culture and needs. Similarly, visitors are a group of people who evaluate a landscape area based on a variety of interests and reasons. According to Chmielewski et al., (2018) and Shahamati, (2020), satisfaction is determined by the study of landscape attributes, whether physical (appearances, diversities, locations, and naturalness) or intangible (sense of place, mystery, rarity, and complexity). Solecka et al., (2022) also stated that perceived landscape quality (PLQ) and landscape aesthetic quality (LAQ) are important factors in determining landscape quality, and Wartmann, Frick, et al., (2021) clarified that the visual became an explanatory factor in predicting familiarity and perceptions in public assessment and judgment.

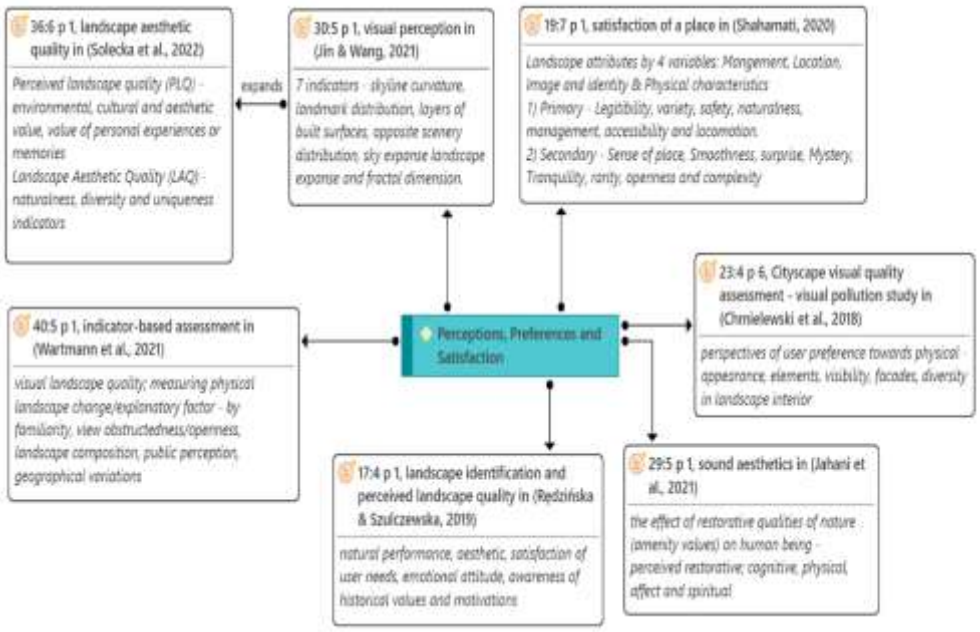

Figure 7. Landscape assessment criteria based on perceptions, preferences and satisfaction.

4.2.2. Visual and aesthetic assessment

The human senses cherish the environment that can be seen and experienced, particularly those with a clear aesthetic appeal. Attractiveness can be defined as the quantification of landscape features and their characteristics, also known as the visual quality indicator (VQI) (Swetnam & Tweed, (2018); Legwaila et al., (2020). According to Cottet et al., (2018); Swetnam & Korenko, (2019); Kalinauskas et al., (2021) & Wan et al., (2022), landscape components and composition, such as structural and compositional elements, spatial arrangement/zoning, size, and scale, are capable of improving the visual aesthetic (Landscape Aesthetic Quality (LAQ)) and scenic quality.

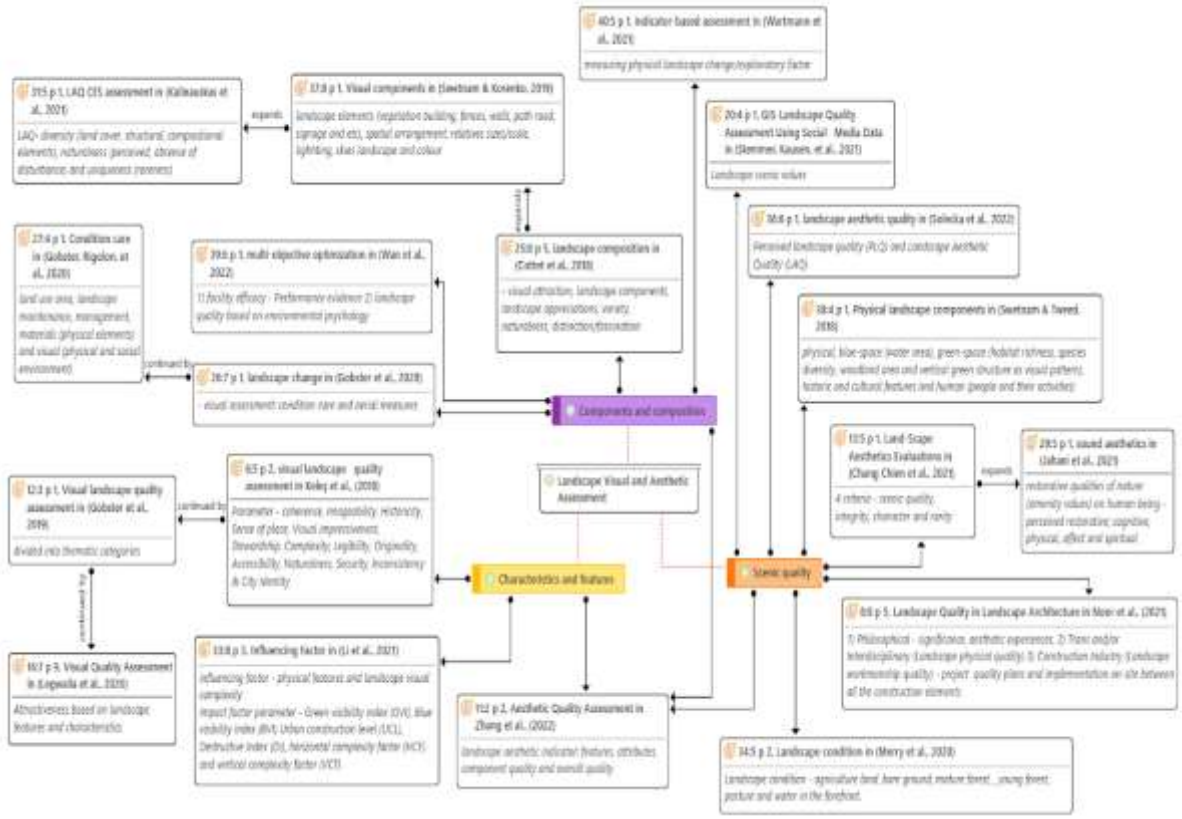

Figure 8. Landscape assessment criteria based on visual and aesthetic.

The characteristics and unique features highlighted in the conceptual, theoretical foundations and construction elements of each landscape area or project became an influencing factor for activities, behavioural changes, and user experiences (Gobster et al., (2019) & Noor et al., (2021)). As a result, impact factors such as the Green Visibility Index (GVI), Blue Visibility Index (BVI), Urban Construction Level (UCL), and Destructive Index (DI) are fundamental parameters that should be considered in all landscape quality research and assessments (Li et al., 2021).

4.2.3. Perceived character and significant values assessment

Identity and image of an area determines the quality of human well-being and surrounding ecosystem. Therefore, landscape identification and perceived landscape quality is crucial in determining the high-quality value of each locality. According to (Kirchhoff et al., 2022), the necessity of construction to achieve development transitions has a variety of effects on environmental and human safety, as well as scenic beauty. As a result, image restoration through landscape quality assessment can ensure excellent natural performance while preserving historical values and raising awareness of significant landscape values. Meanwhile, assessment towards bio-safety factors such as conservation values, carbon sink, operational and material quality (Clarke et al., (2021) & Stauskis, (2020)), and also land efficiency through regional landscape assessment; cultural, ecological, structural, and visual dimensions (Roth et al., (2021) & Jridi et al., (2023)) could ensure that the level of landscape quality in an area can be well maintained.

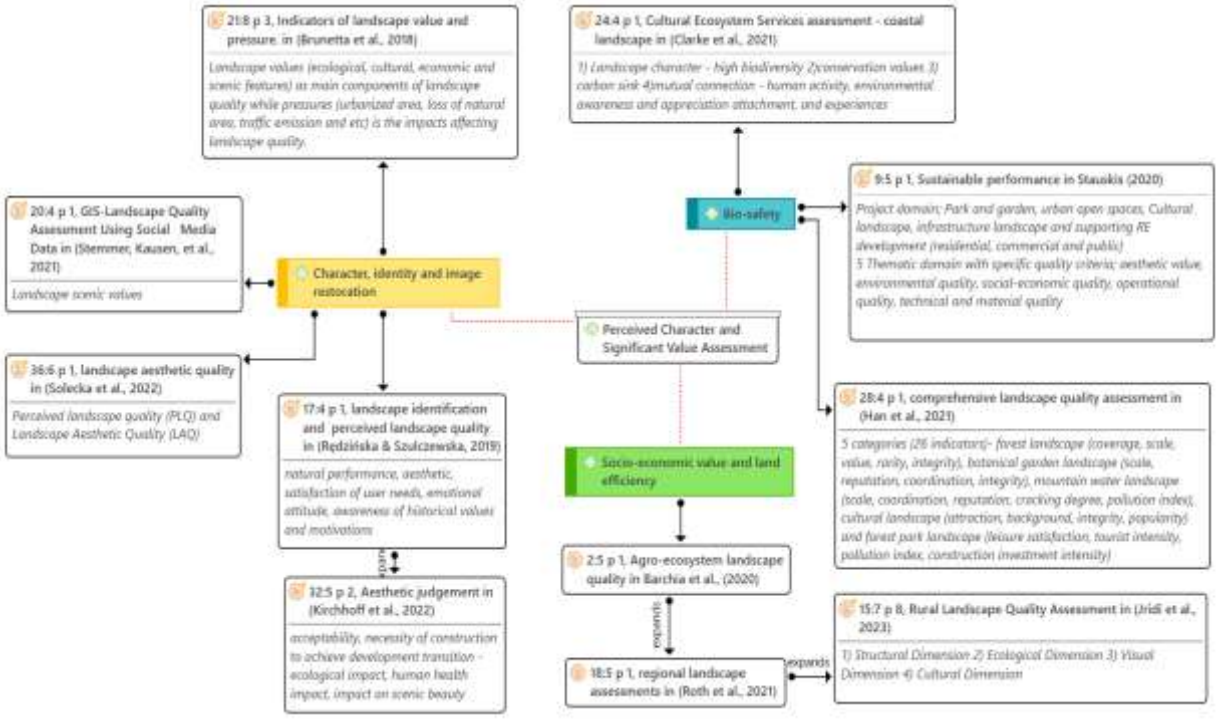

Figure 9. Landscape assessment criteria based on perceived character and significant values.

4.2.4. Environmental condition, sensitivity and trends assessment.

As the population grows, so does the desire and trend to develop the area, whether in terms of development, infrastructure, or socioeconomic aspects. Nonetheless, sensitivity and environmental conditions are important considerations when developing strategies and procedures to achieve high landscape quality standards. Thus, the assessment of ecological risk, patch density, landscape separation/landscape loss index, disruption, and accessibility become the primary concern (Jie Zhang et al., (2023); Jingxiao Zhang et al., (2023); Williams et al., (2023)). Studying environmental inventories has become compulsory in determining planning suitability and sustainable best practices (Fernández-Alvarado & Fernández-Rodríguez, 2022). In addition, despite Landscape Aesthetic Quality (LAQ), Cultural Ecosystem Services (CES) is a particularly significant variable in the landscape sensitivity assessment. According to Kostanjšek & Golobič, (2023), there are four landscape elements that are important in CES provision: vegetation, geomorphology, water, and built elements. These indicate that environmental parameter studies, landscape values, and pressure are genuine factors influencing landscape quality.

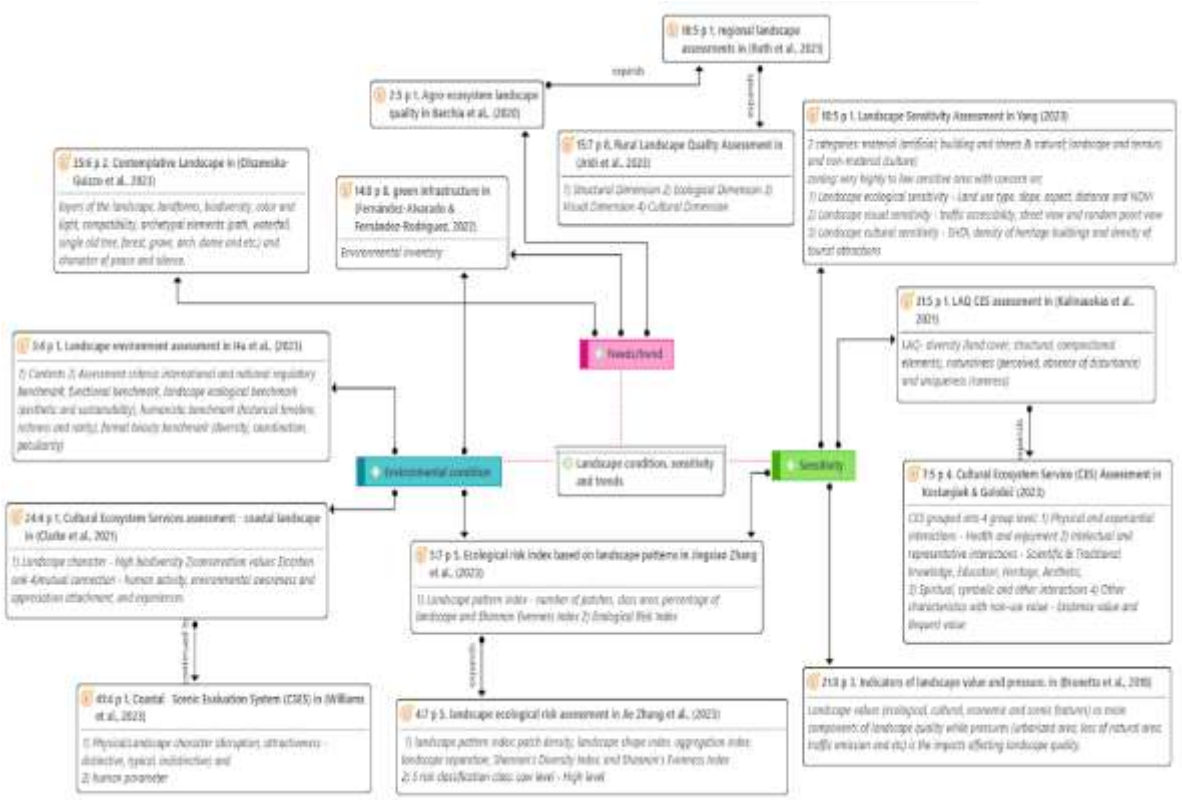

Figure 10. Landscape assessment criteria based on environmental condition, sensitivity and trend.

4.2.5. Constructions, Functional and performances quality assessment

Aside from public preferences, visual aesthetics, significant values, and sensitivity, this study discovered that ecosystem service (bio-engineering and technicalities), performance quality, and construction intensity are among the variables that influence the high-quality physical landscape. Built and non-built environment becomes the parameter to be quantified (Williams et al., 2023). For example, facility efficiency is performance evidence that promotes physical and experiential interaction which benefitted the public (Wan et al., (2022) & Kostanjšek & Golobič, (2023)).

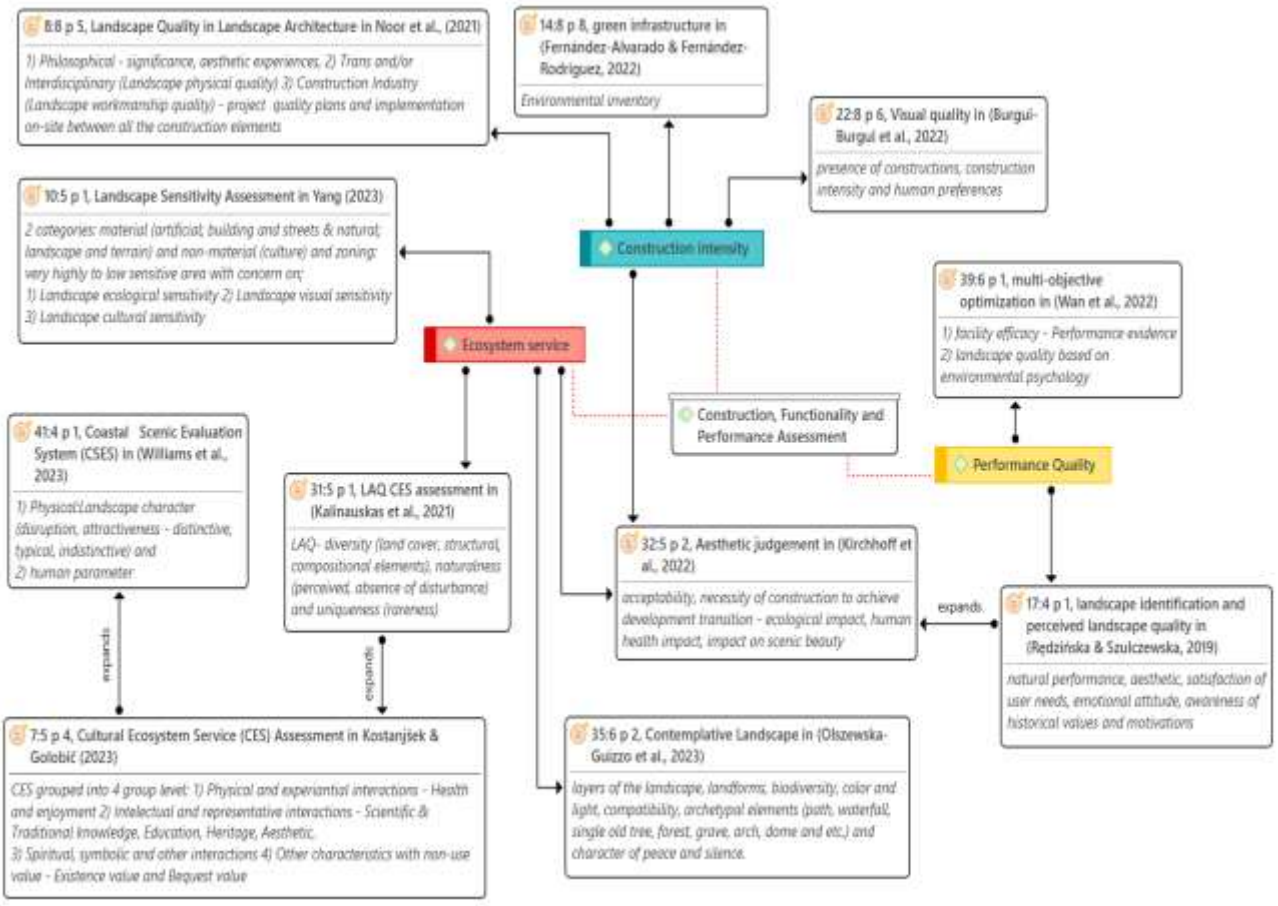

Figure 11. Landscape assessment criteria based on construction, functional and performance quality.

Construction intensity and human preferences (Burgui-Burgui et al., 2022) form a mutually reinforcing relationship that should be fairly quantified in landscape physical quality assessments. Thus, according to Noor et al., (2021), the quality assessment system should consider three major aspects: philosophical (intangible elements), interdisciplinary (landscape physical quality) - visual, cognitive, and experiential, and construction quality (tangible elements) to be assessed on an equal basis.

5.0 RESULT AND DISCUSSION

Landscape perception and valuation are dependent on the relationship between human beings and their environment (Kuiper, 1998; Hedfors, 2015; Qiao et al., 2022) which involved their activities, awareness, appreciation and also experiences which also involved all multisensory of human. By studying these indicators and variables in determining what constitutes a high-quality physical landscape is crucial for providing valuable metrics to planners and policy makers for evaluating the types and parameters to landscape study. The findings suggest that a generic landscape physical quality assessment is possible with caveats to develop a high-quality landscape experience. It also provides insight to the landscape assessment which the industry is expecting.

Table 3. The proposed construct, variables and attributes considered for Landscape Physical Quality Assessment Framework.

Construct	Variables		Example of related attributes/factor
High-Quality Physical Landscape	**INTANGIBLE ELEMENTS – Landscape Content Quality**	Collective memory	Land Preservation
			Scenic quality and views
			Character, identity & image restoration
			Cultural preservation/social value
		Ecological sustainability	Habitat creation, preservation & restoration
			Habitat Quality
			Population and species richness
		Quality and health of landscapes	Recreational & social values
			Flood protection
			Operation & maintenance
		Heritage and culture	Cultural preservation
			Heritage conservation
			Nature Preserve
		Territorial justice	Safety & well-being
			Access & Equity
	TANGIBLE ELEMENTS - Construction Workmanship Quality	Foundation	A groundwork related element/subsystem of landscape construction workmanship such as Site Grading - Land preservation/ restoration
		System and Structural System	A particular method of assembling and constructing Stormwater management, Access & circulation, structural elements such as Retaining wall, small dam and paving
		Features	A layout or design elements that contributes to the visual beauty, elegance, historical consistency, or design integrity, Site furniture/features - renovation work, outdoor lighting and building facilities

The indicated approach has the capacity to be applied across diverse contexts and can enhance comprehensive and integrated landscape evaluations that amalgamate landscape attributes and construction quality in delineating excellent landscapes quality (As shown in Table 3). There is an opportunity to investigate more diverse aspects of landscape design, planning, and development by listing as many indicators and parameters as possible to measure a landscape from various perspectives (Kaymaz, 2012; Schmitz & Vanderheyden, 2016; Spielhofer et al., 2021b), thereby providing a robust database for landscape evaluation across multiple scopes of study and scales. The study uncovered that perception, preferences, as well as detail design (macro elements) and workmanship (micro elements), all played an integral part in valuing and assessing the overall physical landscape quality across a wide range of studies. An alternative strategy (Kuiper, 1998; Nielsen et al., 2007) for assessing landscape quality could be strategic planning that takes into account a generic framework in order to avoid overlooking most of the other aspects of landscape content and elements.

The research is currently ongoing and expanding, with a focus on the need to incorporate workmanship quality into landscape development, planning, and management. Identifying indicators and variables associated with physical assessment of landscape quality study (Table 3) when encountered with act and guidelines challenges has numerous benefits to offer. Understanding and forming a sustainable landscape is essential not only for human well-being but also for the future of Mother Nature. This study has offered both tangible and intangible measures for assessing landscape physical quality altogether, rather than focusing solely on small-scale studies. Therefore, this study proposed constructs, variables and attributes considered for Landscape Physical Quality Assessment Framework as shown in Table 3, which helps in summarizing the generic indicator for assessing the high-quality landscape. The metadata analysis used for this purpose could be used in the long term and in various other facilities as evidence, benefits, or references associated with multiple types of projects in the future.

Professional design-based assessment and public perception-based evaluation are two principal methodologies recognised for quantifying landscape quality (Kaymaz, 2012; Kalinauskas et al., 2021b). In accordance with the metadata analysis and multilayered thematic analysis that has been done through this systematic literature review, landscape evaluations need modification. The proposed conceptual framework

for assessing landscape physical quality is a generic approach that can contribute to methodological expansion and can be used to other rapidly growing regions. This study found that, although dimensions and concepts related to visual landscape quality and non-visual associations have been assessed as landscape indicators, the interplay among landscape metrics, public perspectives and perceptions of landscapes, and construction workmanship quality remains unexamined collectively. Quality in the landscape should focus on two aspects: landscape design (macro elements) which addressed the issue in planning policy, user preferences and perspectives, as individual choices impact the entire population and second, construction workmanship (micro elements) which fulfil the needs of a sustainable environment in rapid development. Thus, these two aspects must be emphasized by policymakers since the scope of landscape quality research is multidisciplinary, causing it complex and challenging to analyze. Therefore, the indicators of measuring landscape quality would need to be adapted to the particularity's local context, however the general approach which considers a varied contents and context should be replicated and integrate a multicriteria analysis for broader considerations and respect towards sustaining the landscape. Thus, this research has proposed an indicator study of measuring criteria for landscape physical quality assessment for Malaysian Construction Industry (Table 3).

6.0 CONCLUSION

Landscape-scale and reputation have emerged as critical factors in sustainable development competitiveness, attraction, and even ecosystem risk and complexity. Each assessment method has specific benefits and drawbacks when determining overall landscape quality, particularly in a broader scope of study and landscape-specific territory and scale. Indicators commonly used in landscape quality assessment studies are inadequate and need to be revised, causing industry players to become uncertain when making assessments and planning strategies. As a result, based on the specifications set forth by the study and the current state of landscape quality assessment in Malaysia, the purpose of this paper is to solve problems by defining and exploring effective key criteria for measuring landscape physical quality for the Malaysian construction industry. In accordance with the metadata findings, landscape quality assessment should have been evaluated using a broader and more diverse technique, as mentioned in the discussion, which identified five key categories: 1) perceived character and significant values; 2) perception, preferences, and satisfaction; 3) landscape visual and aesthetic; 4) environmental condition, sensitivity, and trend; and 5) construction, functional, and performance quality. These 5 categories imply that a landscape composed of integrated multidisciplinary factors should be carefully assessed using a comprehensive assessment framework that incorporates human needs, technicalities (bio-engineering), and environmental performance aspects. In the long run, alongside competing in fostering the creation of a high-quality landscape, proper standard assessment and quality check measures could provide extensive data analysis as well as a performance scale for Malaysia's construction industry while achieving our country's sustainable revolution goals and setting a high standard for quality rating worldwide.

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7.0 REFERENCES

Ahern, K., & Cole, L. (2009). Guidelines for Implementing the European Landscape Convention Part 2: Integrating the Intent of the ELC into Plans, Policies and Strategies. *Strategies*, 44. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/320686/integrating-intent-elc-into-plans-policies-strategies.pdf

Aziz, N. A. A. (2022). Empowering Landscape Best Management Practices (BMP) For Better Living Environment Towards Urban Nation - I-KPKT. In *I-KPKT*. https://ikpkt.kpkt.gov.my/index.php/program/penerbitan-penyelidikan/erencana/item/86-empowering-landscape-best-management-practices-bmp-for-better-living-environment-towards-urban-nation

Battis-Schinker, E., Al-Alawi, S., Knippschild, R., Gmur, K., Książek, S., Kukuła, M., & Belof, M. (2021). Towards quality of life indicators for historic urban landscapes – Insight into a German-Polish research project. *Environmental and Sustainability Indicators*, *10*(December 2020). https://doi.org/10.1016/j.indic.2020.100094

Bhat, A. (2018). *Conceptual Research: Definition, Framework, Example, and Advantages*. https://www.questionpro.com/blog/conceptual-research/

Burgui-Burgui, M., Ibarra-Benlloch, P., Rodrigues, M., & da Silva, E. V. (2022). The effect of construction intensity on landscape preferences in Cuban tourist resorts. *Environmental Development*, *44*, 100763. https://doi.org/https://doi.org/10.1016/j.envdev.2022.100763

Chmielewski, S., Samulowska, M., Lupa, M., Lee, D., & Zagajewski, B. (2018). Citizen science and WebGIS for outdoor advertisement visual pollution assessment. *Computers, Environment and Urban Systems*, *67*, 97–109. https://doi.org/https://doi.org/10.1016/j.compenvurbsys.2017.09.001

CIDB (2015) Analisa Kualiti Pembinaan bagi Kerja Mewajibkan Pelaksanaan QLASSIC Bagi Projek Kerajaan, Construction Industry Development Board, Kuala Lumpur

Clarke, B., Thet, A. K., Sandhu, H., & Dittmann, S. (2021). Integrating Cultural Ecosystem Services valuation into coastal wetlands restoration: A case study from South Australia. *Environmental Science & Policy*, *116*, 220–229. https://doi.org/https://doi.org/10.1016/j.envsci.2020.11.014

Cottet, M., Vaudor, L., Tronchère, H., Roux-Michollet, D., Augendre, M., & Brault, V. (2018). Using gaze behavior to gain insights into the impacts of naturalness on city dwellers' perceptions and valuation of a landscape. *Journal of Environmental Psychology*, *60*, 9–20. https://doi.org/https://doi.org/10.1016/j.jenvp.2018.09.001

Council of Europe. (2006). *Landscape and sustainable development: challenges of the European Landscape Convention* (Council of Europe (ed.)). Council of Europe Publishing.

Criterion Planner (2014). A Global Survey of Urban Sustainability Rating Tools, http://crit.com/wp-content/uploads/2014/11/criterion_planners_sustainability_ratings_tool.pdf

Daniel, T. C. (2001). Whither scenic beauty? Visual landscape quality assessment in the 21st century. *Landscape and Urban Planning*, *54*(1–4), 267–281. https://doi.org/10.1016/S0169-2046(01)00141-4

Davoudi, S., & Brooks, E. (2019). *Landscape quality: A rapid review of the evidence* (Issue September). www.gov.uk/government/publications

Fernández-Alvarado, J. F., & Fernández-Rodríguez, S. (2022). 3D environmental urban BIM using LiDAR data for visualisation on Google Earth. *Automation in Construction*, *138*. https://doi.org/10.1016/j.autcon.2022.104251

Gobster, P. H., Ribe, R. G., & Palmer, J. F. (2019). Themes and trends in visual assessment research: Introduction to the Landscape and Urban Planning special collection on the visual assessment of landscapes. *Landscape and Urban Planning*, *191*, 103635. https://doi.org/https://doi.org/10.1016/j.landurbplan.2019.103635

Han, X., Sun, T., & Cao, T. (2021). Study on landscape quality assessment of urban forest parks: Take Nanjing Zijinshan National Forest Park as an example. *Ecological Indicators*, *120*, 106902. https://doi.org/https://doi.org/10.1016/j.ecolind.2020.106902

Hedfors, P. (2011). Systems Theory in Landscape Architecture. *Conference Paper: Urban Nature: Council of Educators in Landsacpe Architecture CELA, April 2011*, 1–13.

Hisschemöller, M., Kireyeu, V., Freude, T., Guerin, F., Likhacheva, O., & Pierantoni, I. (2022). Conflicting perspectives on urban landscape quality in six urban regions in Europe and their implications for urban transitions. *Cities*, *131*(October). https://doi.org/10.1016/j.cities.2022.104021

Huang, J., Wang, Y., & Zhang, L. (2022). Identifying spatial priority of ecological restoration dependent on landscape quality trends in metropolitan areas. *Land*, *11*(1). https://doi.org/10.3390/land11010027

IFLA. (2022). *IFLA World · International Federation of Landscape Architects*. International Federations of Landscape Architects. http://iflaonline.org/

Jridi, L., Kalaitzidis, C., & Alexakis, D. D. (2023). Quantitative Landscape Analysis Using Earth-Observation Data: An Example from Chania, Crete, Greece. *Land*, *12*(5). https://doi.org/10.3390/land12050999

Jabatan Kerjaraya Malaysia (2015) Carta Organisasi Cawangan dan Pengurusan, Jabatan Kerjaraya Malaysia,

Kuala Lumpur

Kalinauskas, M., Mikša, K., Inácio, M., Gomes, E., & Pereira, P. (2021a). Mapping and assessment of landscape aesthetic quality in Lithuania. *Journal of Environmental Management*, *286*, 112239. https://doi.org/https://doi.org/10.1016/j.jenvman.2021.112239

Kalinauskas, M., Mikša, K., Inácio, M., Gomes, E., & Pereira, P. (2021b). Mapping and assessment of landscape aesthetic quality in Lithuania. *Journal of Environmental Management*, *286*(March). https://doi.org/10.1016/j.jenvman.2021.112239

Kamal, M. F. M., Hassan, P., Affandi, H. M., & Noor, M. S. M. (2021). Landscape Workmanship Quality Through Quality Assessment System: Why Noncompliance Continued? *Alam Cipta*, *14*(1), 11–19.

Kaymaz, I. C. (2012). Landscape Perception. In *Landscape Planning*. https://doi.org/10.1016/B978-008044910-4.00464-8

Kim, D., & Son, Y. (2024). An Assessment of Landscape Perception Using a Normalised Naturalness Index in the Greater Seoul Area. Land, 13(6). https://doi.org/10.3390/land13060750

Kirchhoff, T., Ramisch, K., Feucht, T., Reif, C., & Suda, M. (2022). Visual evaluations of wind turbines: Judgments of scenic beauty or of moral desirability? *Landscape and Urban Planning*, *226*, 104509. https://doi.org/https://doi.org/10.1016/j.landurbplan.2022.104509

Kostanjšek, B., & Golobič, M. (2023). Cultural ecosystem services of landscape elements and their contribution to landscape identity: The case of Slovenia. *Ecological Indicators*, *157*(December). https://doi.org/10.1016/j.ecolind.2023.111224

Kuiper, J. (1998). *Landscape quality based upon diversity, coherence and continuity Landscape planning.pdf*. Wageningen Agricultural University.

Legwaila, I. A., Lange, E., & Cripps, J. (2020). Assessing the effects of quarry treatment options on the attractiveness of reclaimed limestone quarries using 3D-visualizations. *International Journal of Mining, Reclamation and Environment*, *34*(3), 179–197. https://doi.org/10.1080/17480930.2018.1561387

Li, X., Li, L., Wang, X., Lin, Q., Wu, D., Dong, Y., & Han, S. (2021). Visual quality evaluation model of an urban river landscape based on random forest. *Ecological Indicators*, *133*, 108381. https://doi.org/10.1016/j.ecolind.2021.108381

Lothian, A. (1999). Landscape and the philosophy of aesthetics: is landscape quality inherent in the landscape or in the eye of the beholder? *Landscape and Urban Planning*, *44*(4), 177–198. https://doi.org/https://doi.org/10.1016/S0169-2046(99)00019-5

Mundher, R., Bakar, S. A., Maulan, S., Yusof, M. J. M., Al-Sharaa, A., Aziz, A., & Gao, H. (2022). Aesthetic Quality Assessment of Landscapes as a Model for Urban Forest Areas: A Systematic Literature Review. *Forests*, *13*(7), 1–22. https://doi.org/10.3390/f13070991

Musa, M. F., Mohammad, M. F., Mahbub, R., & Yusof, M. R. (2018). Adopting Modular Construction in the Malaysian Construction Industry. *Asian Journal of Environment-Behaviour Studies*, *3*. https://doi.org/10.21834/aje-bs.v3i10.307

Nielsen, J. B., Dam, T., & Thompson, I. (2007). European landscape architecture best practice in detailing. In *European Landscape Architecture: Best Practice in Detailing*. https://doi.org/10.4324/9780203622995

Noor, M S M, Hassan, P., Affandi, H. M., & Kamal, M. F. M. (2021). Landscape Workmanship Quality Through Quality Assessment System: Why Noncompliance Continued? *Alam Cipta*, *14*(1), 11–19. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85109823819&partnerID=40&md5=34a2e3f932ff14339a849037fe365357

Othman, H, (2020) Perbincangan Awal Review Kompetensi Pembinaan Landskap, Construction Industry Development Board, Kuala Lumpur

Pillay, S. (2017). Landscape Architect is Not a Glorified Gardener, https://www.nst.com.my/news/nation/2017/07/253735/landscape-architects-are-not-glorified-

gardeners

Qiao, X.-J., Liu, Y., & Feng, J. (2022). Evaluating the Landscape Quality of Residential Communities: A Case Study of the Chinese City Yangling. *Land*, *12*(1), 57. https://doi.org/10.3390/land12010057

Roth, M., Hildebrandt, S., Walz, U., & Wende, W. (2021). Large-area empirically based visual landscape quality assessment for spatial planning—a validation approach by method triangulation. *Sustainability (Switzerland)*, *13*(4), 1–23. https://doi.org/10.3390/su13041891

Roy, S., Byrne, J., & Pickering, C. (2012). A systematic quantitative review of urban tree benefits, costs, and assessment methods across cities in different climatic zones. *Urban Forestry and Urban Greening*, *11*(4), 351–363. https://doi.org/10.1016/j.ufug.2012.06.006

Sahragard, F. A., Danehkar, A., & Jahani, A. (2024). Modeling landscape visual aesthetic quality assessment towards tourism development in protected areas Modeling Landscape Visual Aesthetic Quality Assessment Towards Tourism Development in Protected Areas. May. https://doi.org/10.48308/ENVS.2024.1335

Sahraoui, Y., Clauzel, C., & Foltête, J. C. (2021). A metrics-based approach for modeling covariation of visual and ecological landscape qualities. *Ecological Indicators*, *123*, 107331. https://doi.org/10.1016/J.ECOLIND.2020.107331

Salih, S., Hamid, T. A., Ibrahim, R., Ashari, A., Abdullah, S. F., & Tyng, C. Sen. (2023). A Scoping Review on Determinants of Active Ageing in Southeast Asian Region. *Sains Malaysiana*, *52*(5), 1523–1543. https://doi.org/10.17576/jsm-2023-5205-15

San Martin Saldias, D., & McGlade, J. (2022). A method for considering the evolution of the visible landscape. *Journal of Geographical Systems*, *0123456789*. https://doi.org/10.1007/s10109-022-00398-2

Schmitz, S., & Vanderheyden, V. (2016). Reflexive loops on scaling issues in landscape quality assessment. *Land Use Policy*, *53*, 3–7. https://doi.org/10.1016/j.landusepol.2015.07.020

Shahamati, S. (2020). Assessment of landscape quality based on the perception of people: Study of two parks in newcastle upon tyne. *European Journal of Environmental Sciences*, *10*(2), 65–75. https://doi.org/10.14712/23361964.2020.8

SIRIM (2021) Webinar Penarafan PhJKR bagi Bangunan Kediaman dan Bukan Kediaman, Standard and Industrial Research Institute of Malaysia, Shah Alam

Solecka, I., Rinne, T., Caracciolo Martins, R., Kytta, M., & Albert, C. (2022). Important places in landscape – investigating the determinants of perceived landscape value in the suburban area of Wrocław, Poland. *Landscape and Urban Planning*, *218*, 104289. https://doi.org/https://doi.org/10.1016/j.landurbplan.2021.104289

Song, S., Wang, S., Shi, M., Hu, S., & Xu, D. (2022). Urban blue–green space landscape ecological health assessment based on the integration of pattern, process, function and sustainability. *Scientific Reports*, *12*(1), 1–16. https://doi.org/10.1038/s41598-022-11960-9

Spielhofer, R., Hunziker, M., Kienast, F., Wissen Hayek, U., & Grêt-Regamey, A. (2021a). Does rated visual landscape quality match visual features? An analysis for renewable energy landscapes. *Landscape and Urban Planning*, *209*(February). https://doi.org/10.1016/j.landurbplan.2020.104000

Spielhofer, R., Hunziker, M., Kienast, F., Wissen Hayek, U., & Grêt-Regamey, A. (2021b). Does rated visual landscape quality match visual features? An analysis for renewable energy landscapes. *Landscape and Urban Planning*, *209*, 104000. https://doi.org/10.1016/J.LANDURBPLAN.2020.104000

Stauskis, G. (2020). Identifying key criteria for quality assessment of landscape architecture projects. *Architecture and Urban Planning*, *16*(1), 5–11. https://doi.org/10.2478/aup-2020-0002

Swetnam, R. D., & Korenko, J. (2019). Can computer game landscapes target new audiences for landscape quality assessment? *Applied Geography*, *113*, 102102. https://doi.org/https://doi.org/10.1016/j.apgeog.2019.102102

Swetnam, R. D., & Tweed, F. S. (2018). A tale of two landscapes: Transferring landscape quality metrics from Wales to Iceland. *Land Use Policy*, *76*, 565–576.

https://doi.org/https://doi.org/10.1016/j.landusepol.2018.02.037

Tahir, O. (2021) Webinar on Landscape and Sustainability: Are We Ready for 2021 Challenges? Universiti Putra Malaysia, Serdang

Wan, S., Xu, L., Qi, Q., Yang, H., & Zhou, Y. (2022). Building a multi-objective optimization model for Sponge City projects. *Urban Climate*, *43*, 101171. https://doi.org/https://doi.org/10.1016/j.uclim.2022.101171

Wartmann, F. M., Frick, J., Kienast, F., & Hunziker, M. (2021). Factors influencing visual landscape quality perceived by the public. Results from a national survey. *Landscape and Urban Planning*, *208*, 104024. https://doi.org/10.1016/J.LANDURBPLAN.2020.104024

Wartmann, F. M., Stride, C. B., Kienast, F., & Hunziker, M. (2021a). Relating landscape ecological metrics with public survey data on perceived landscape quality and place attachment. *Landscape Ecology*, *36*(8), 2367–2393. https://doi.org/10.1007/s10980-021-01290-y

Williams, A. T., Mooser, A., Anfuso, G., Herbert, V., & Aucelli, P. P. C. (2023). Coastal scenic assessment in northern France: An attempt to quantify scenic beauty and analyse the role played by the Conservatoire du littoral. *Ocean & Coastal Management*, *236*, 106446. https://doi.org/https://doi.org/10.1016/j.ocecoaman.2022.106446

Windhager, S., Steiner, F., Simmons, M. T., & Heymann, D. (2010). Toward Ecosystem Services as a Basis for Design. *Landscape Journal*, *29*(2), 107–123. https://doi.org/10.3368/lj.29.2.107

Xi, H., Huang, C., Ou, W., Li, J., Wang, F., Tao, Q., & Tao, Y. (2024). An assessment framework for landscape sustainability based on ecosystem service supply-flow-demand. Landscape Ecology, 39(3), 1–19. https://doi.org/10.1007/s10980-024-01855-7

Zairul, M. (2020). A thematic review on student-centred learning in the studio education. *Journal of Critical Reviews*, *7*(2), 504–511. https://doi.org/10.31838/jcr.07.02.95

Zhang, Jie, Zheng, S., Zhou, T., Yang, Z., Zhang, Y., & Sun, Y. (2023). Research on the Establishment of Carbon Inversion Model in Engebei Ecological Demonstration Area of the Kubuqi Desert Based on Remote Sensing Data. *IEEE Access*, *11*, 28151–28161. https://doi.org/10.1109/ACCESS.2023.3255879

Zhang, Jingxiao, Hu, R., Cheng, X., Christos, V., Philbin, S. P., Zhao, R., & Zhao, X. (2023). Assessing the landscape ecological risk of road construction: The case of the Phnom Penh-Sihanoukville Expressway in Cambodia. *Ecological Indicators*, *154*(July), 110582. https://doi.org/10.1016/j.ecolind.2023.110582