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AN EMPIRICAL STUDY IN PERCEIVING CAMPUS LEGIBILITY THROUGH COGNITIVE MAPPING

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Abstract

University campuses rely on imageability and legibility to support navigation and identity, yet complex layouts can undermine orientation and student experience. This study examines campus imageability at Universiti Malaya using a mixed-methods design: a questionnaire (n=50), cognitive mapping tasks grounded in Lynch's five elements, and semi-structured interviews (n=10). Descriptive and thematic analyses assessed wayfinding challenges, the salience of spatial elements, and perceived identity. Results show landmarks (e.g., Dewan Tunku Canselor, UM Library) and edges (notably Varsity Lake) dominate mental maps, while ambiguous intersections, inconsistent signage, and long, indirect pathways contribute to navigation friction. Pathways such as Jalan Lingkungan Budi anchor movement but nodes and districts are recalled less reliably. The findings indicate that a small set of highly imageable elements carries most of the cognitive load for wayfinding and belonging. We recommend (i) targeted signage and pathway reinforcement, (ii) coherent zoning into named "districts," and (iii) incremental adoption of digital/AR guides for first-time users. Enhancing legibility can strengthen campus identity and improve everyday student experience

Keywords: Imageability, Mental mapping, Legibility, Campus Image and Identity

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INTRODUCTION

Imageability and legibility are crucial in a campus environment for effective navigation and creating a sense of ease. Imageability involves evoking clear mental images, making landmarks and spaces easily recognizable. Legibility involves organizing the environment intuitively, aiding orientation and movement. These elements make navigation more intuitive, reducing cognitive load on visitors and new students unfamiliar with the campus layout.

Complex campus layouts can lead to confusion, frustration, and negative experiences for students, especially newcomers. Overly complicated layouts discourage spontaneous exploration and limit engagement with campus resources. Imageability encompasses the elements that make the campus recognizable and memorable, influencing how people navigate and interact with space. This study focuses on legibility elements such as visibility of landmarks, organization of pathways and nodes, and overall aesthetics of the campus environment along the edge and characteristics of an area to form a signature district within the campus. Therefore, this research is seeking to find an answer to the question on what are the criteria in creating a legible campus that benefit students and enhances the image and identity of the campus environment? This question focuses on identifying the fundamental elements of campus design that make UM an accessible and cohesive environment, thereby strengthening its identity.

This research is a quest to explore the concept of campus legibility and its effect on students' experiences and the overall identity of the campus environment. It also aims to identify and analyse the factors that contribute to the campus's imageability using cognitive mapping techniques within the campus community. Based on these objectives:

- i. to explore and analyse students' perceptions of their image and identity within the campus environment and
- ii. to assess the legibility of the campus from the students' cognitive perspectives, focusing on how spatial design, signage, and the overall campus layout influence their navigation, sense of belonging, and identification with the institution.

The study collects qualitative and quantitative data via cognitive maps to understand students' campus layout experiences and perceptions. It aims to identify patterns in how students identify campus features and spaces, and their emotional connections to university areas, thereby developing a comprehensive approach to perceived campus image and cognitive navigation.

LITERATURE REVIEW

A campus's performance is determined by its ability to meet the biological, psychological, social, and cultural needs of its communities (Lynch, 1960). A well-functioning campus ensures basic biological requirements like clean air, safe drinking water, and housing, while also nurturing residents' psychological wellbeing through relaxation, reflection, and community interaction (Ding et al., 2024). Active transportation infrastructure positively impacts students' physical activity, while natural environments like perceived naturalness, blue space, and greenness support mental health and quality of life. Mental mapping has been widely applied in Malaysian urban contexts to identify legible elements and spatial cognition, particularly in historical districts (Lai & Ujang, 2012), demonstrating its reliability for capturing user perceptions of place.

Theoretical Foundations of Campus Image and Identity

In his seminal work for *The Image of the City* (1960), Kevin Lynch explores how individuals mentally organize and interpret urban environments, focusing on the alignment of physical layout with human perception and cognitive mapping. Lynch argues that an effective urban environment meets cultural and social needs while ensuring accessibility to transportation and amenities. Gordon Cullen's *The Concise Townscape* (1961) emphasizes Lynch's concept of environmental imageability, detailing five key elements that contribute to a city's legibility: paths, edges, landmarks, nodes, and districts. Christian Norberg-Schulz's *Genius Loci* (1980) emphasizes the importance of architecture in shaping a sense of place and the identity and spirit of a location. These theories enhance our understanding of urban legibility by illustrating how humans experience and interpret their physical surroundings. Lynch's mappable elements, Cullen's pedestrian perspectives, and Norberg Schulz's architectural considerations emphasize the importance of creating navigable and meaningful environments, particularly in campus environments where spatial clarity, identity, and accessibility significantly impact users' experiences, shaping research on orientation and place attachment.

Understanding the Concept of Genius Loci and the Essence of a Place

The concept of genius loci, or the "spirit of place," suggests that a location's atmosphere and character are shaped by its inhabitants, who are considered its "geniuses" or caretakers. These individuals, through their presence, interactions, memories, and personal connections, create a unique identity for the place.

This influence extends beyond physical presence, encompassing shared experiences, emotions, and collective perceptions which contribute to essence or "spirit" that defines place (Vecco, 2020). Campus attachment, on the other hand, is the emotional bond individuals form with specific places, expressed through emotions, beliefs, knowledge, and actions (Hidalgo & Hernandez, 2001). This

attachment is not only emotional but also functional, enhancing a sense of belonging, familiarity, and the creation of great leaders (Stokols & Shumaker 1981). The study emphasizes the need to understand the psychological sense of place in campus and advocate for identifying place attachment dimensions to better understand the relationship between attachment, perception, and the identity of places.

Genius loci, or the "spirit of place," is a concept that helps identify both tangible and intangible values that are crucial for fostering a human-centred approach in sustainable development, particularly in a campus environment (Vecco, 2020). Tangible values, such as architecture, landscape, and spatial organization, form the visible foundation of a campus's identity. This aligns with findings on place attachment within Malaysian urban environments, where the value of place significantly shapes users' lived experiences and sense of belonging (Tan & Ujang, 2014). Intangible values, such as lived experiences, traditions, memories, and social interactions, give a campus its unique personality and emotional resonance. Understanding genius loci is essential for creating functional, meaningful, and supportive spaces for a strong campus community. Institutions can foster a sense of belonging and identity among students, faculty, and staff by recognizing both tangible and intangible elements. This approach to campus design promotes a sustainable, vibrant community that values both physical and experiential qualities, enhancing the educational experience and nurturing personal growth and wellbeing.

Exploring Campus Legibility through Mental Mapping

Mental maps are a person's perception of their surroundings, created by the brain subconsciously to understand their environment and interact with elements (Guelton, 2023). Lynch's Theory of Legibility identifies five legible elements that influence citizens' mental maps: paths, edges, districts, nodes, and landmarks as shown in Figure 1. Mental maps can be interpreted in various ways, including cognitive maps and concept maps, also known as heuristic or mind maps each representing distinct contexts within the mental mapping framework (Guelton, 2023). This study focuses on how individuals navigate physical spaces and how these routes contribute to memory formation and internal spatial representations. Mental mapping and cognitive mapping share similar functions and outcomes.

Tan and Ujang (2012) emphasize the significance of perceived image in shaping a place's reputation. Their study on Kuala Lumpur's historical district suggests mental mapping as a reliable technique for understanding people's cognition of an area. Irfan's research highlights the role of student satisfaction in mediating the relationship between perceived university image and reputation, creating a genius loci that enhances student experience on campus. Deniz and Topcu (2012) criticized undefined and vacant areas between faculty buildings and unstructured spaces on the Selcuk University campus that lack a clear

purpose. Research shows that up to 90% of individuals receive environmental information through visual perception (Latypova et al., (2021).

Examining architectural structures is crucial for understanding how cityscapes influence perception and spatial cognition. Cognitive mapping, through visual, cognitive, and perception-based studies, is often used to define campus environments. Understanding community perception of campus open spaces informs current campus design trends, aiming for liveable environments that prioritize usability and quality of life.

A study in Turkey employing cognitive mapping and photo projective methods found that students associated cafes, green spaces, and panoramic views with a strong sense of belonging. In contrast, Universiti Malaya students emphasized the calming presence of roadside trees as key elements supporting orientation. Together, these findings illustrate how cognitive mapping consistently highlights the influence of natural and social features in reinforcing campus legibility and identity.

Advancements in Digital Campus Wayfinding:

While Lynch's (1960) framework remains foundational, recent studies highlight the role of digital tools in enhancing campus legibility. AI-assisted navigation systems, such as augmented reality (AR) campus guides and smart signage systems, have been implemented in universities like MIT and NTU Singapore, improving real-time orientation for students (Zhang et al., 2024). Studies indicate that students increasingly rely on mobile mapping apps rather than traditional landmarks for navigation, shifting the way cognitive maps are formed (Turk et al., 2015). Integrating these digital systems into future research on campus wayfinding could offer a more precise analysis of spatial cognition. The study highlights the significance of spatial-cognitive features in urban and architectural navigation. It introduces a new experimental technique using 3D isovists to measure spatial distinctiveness and evaluate architectural designs' effectiveness in wayfinding. (Bhatia et al., 2013). Principal component analysis differentiates between monotonous and structurally distinct regions, providing a quantitative method for assessing architectural saliency.

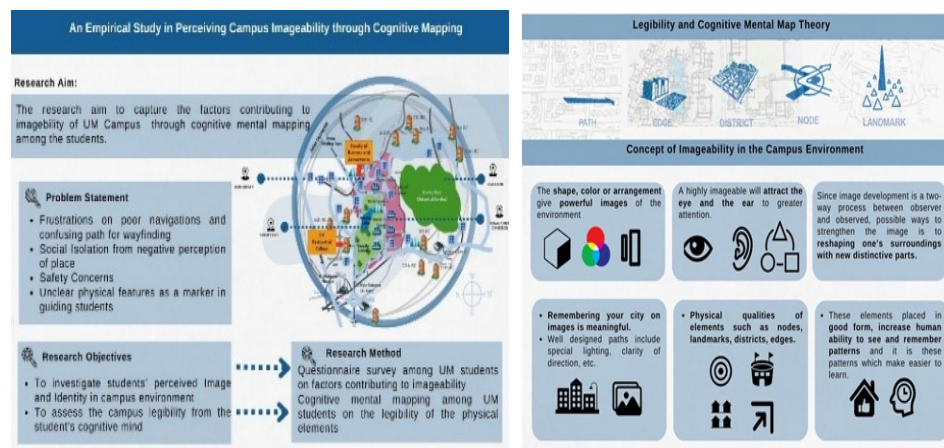


Figure 1: Diagram of Research Conceptual Framework
Source: Authors (2025)

RESEARCH METHODOLOGY

This study employed a multi-method approach combining quantitative surveys, qualitative interviews, and cognitive mapping techniques to analyse campus legibility at Universiti Malaya. The integration of these methods reflects a pragmatic paradigm, which values the use of multiple perspectives to comprehensively address the research problem.

Multi- Method of Data Collections

The study approached data collection through both objective and subjective lenses as below:

- i) **Quantitative Approach: Objective Data Collection** - A questionnaire was given to 50 students from different faculties to collect data on spatial layout and accessibility. The survey examined students' perceptions of campus layout and accessibility, the frequency and types of wayfinding challenges they encountered, and their attitudes toward campus identity and imageability, with responses analysed using descriptive statistics to identify common patterns and highlight navigation trends across the student population.
- ii) **Quantitative Approach: Objective Data Collection Cognitive Mapping** – 50 participants created mental maps of a campus using Lynch's (1960) framework to explore their spatial experiences. Thematic analysis of these maps identified common spatial patterns and individual perceptions. The maps gave valuable insight into how students perceive and priorities campus spaces. Participants were free to sketch in their own way, without strict instructions, so their drawings reflected genuine impressions rather than guided answers. Students who were very familiar with the campus and those

who were less experienced were both included, ensuring a range of perspectives. From this, the study was able to see not only the strengths and weaknesses of UM's spatial design but also how students mentally organise and make sense of a complex environment.

- iii) **Qualitative Approach: Semi-Structured Interviews** - Interviews with 10 students revealed recurring themes on how navigation challenges shape their sense of belonging and engagement on campus. The interviews focused on how difficulties in navigation affected their daily lives, their sense of safety, and even how connected they felt to the university. Students were asked open questions but encouraged to share their own stories.

Overall, merging spatial analysis with experiential insights provides a comprehensive understanding of the campus, addressing both its physical layout and its impact on students' sense of place and navigation.

Universiti Malaya as a Case study

Universiti Malaya (UM) faces spatial challenges on its Kuala Lumpur campus due to architectural inconsistencies and poor legibility, impacting safety. Mental mapping, an individual's spatial understanding, aids navigation and develops over time. Cognitive maps, internal environmental representations, use geometric features to organize data. While mental maps show familiarity, cognitive maps detail environmental information. UM's diverse spatial environment offers a suitable context for studying how design affects campus legibility and student navigation.



Figure 2: UM Campus Map & Urban Campus

Source: Photos taken during fieldwork by the Authors. (2023, Oct 21)

Selection of Participants

Data were gathered through surveys, semi-structured interviews, and cognitive mapping tasks. A total of 50 students, balanced by gender and drawn from diverse faculties were selected, to participate in the study. The use of structured interview

protocols and standardised cognitive mapping exercises ensured response consistency, minimised bias and strengthened the validity of perceptions captured.

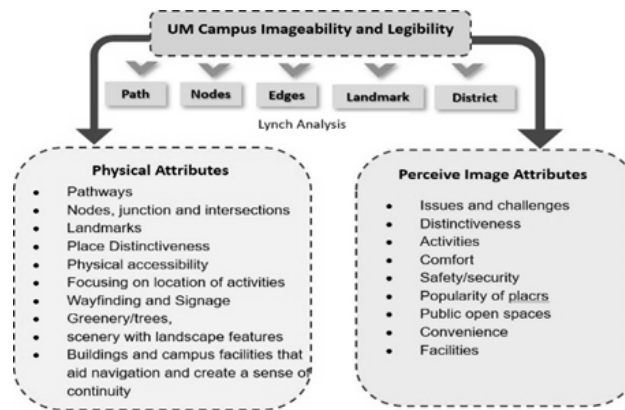


Figure 3: Physical and perceived image attributes
Source: Authors (2025)

Research Instruments

This study investigated campus legibility and identity using mental mapping and architectural theory with Lynch's five elements (1960) illustrated in Figure 3 is used to enhance spatial perception and cognition within the UM campus, drawing on Deniz and Topcu (2012). Interactive and free-hand mapping tools are utilised to capture students' subjective spatial knowledge and perceptions of campus environments, their experiences, and suggestions for improvement.

This study analysed campus physical and image attributes using primary data from mental mapping and surveys, supplemented by secondary data, to improve design and experiential outcomes. Cognitive maps were assessed using Lynch's (1960) urban legibility elements, considering landmark recall frequency, spatial distortion, and navigational significance. Statistical analysis correlated survey results with cognitive maps to confirm the reliability of mental representations for campus wayfinding.

RESULTS AND FINDINGS

The study employed a mixed-methods approach in analysing the collected data. Quantitative survey responses were examined using descriptive statistics to identify trends in wayfinding challenges, while qualitative data from interviews and cognitive mapping were thematically analysed to capture patterns of perception and spatial representation. This dual approach provided a

comprehensive assessment of campus legibility and identity, allowing both objective measures and experiential insights to be systematically integrated.

Questionnaire Survey Analysis

The Universiti Malaya (UM) campus faces challenges in navigation due to ambiguous intersections and a lack of clear signage. 50% of respondents find these intersections confusing and inefficient, while 75% express frustration with the lack of clear pathways, as shown in Figure 4. This feedback highlights the need for improved campus wayfinding strategies, such as better signage, distinct landmarks, and improved pathway layouts, to create a more navigable and student-friendly environment. Based on Figure 4, Students face lengthy walking distances to key locations, leading to shortcuts and reduced legibility. The lack of clear signage and extended pathways contributes to students seeking shortcuts, making the educational and residential zones less navigable and harder to interpret, ultimately affecting the overall campus experiences.

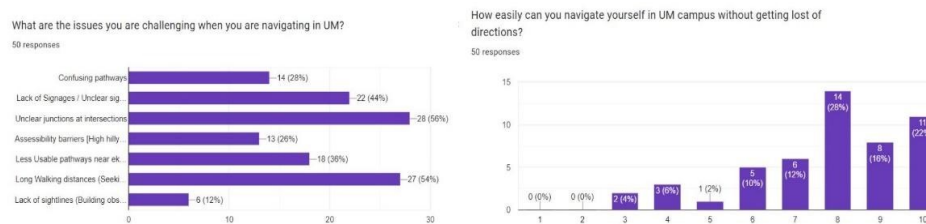


Figure 4a and 4b: Legibility Issue & Challenges and Level of ease in Navigation in UM Campus.

Source: Authors (2025)

Based on Figure 4, Majority of students (80%) found the UM campus pathways to be somewhat easy to navigate, with some having minor difficulties in locating specific destinations. New or infrequent visitors may struggle more in certain areas. The study suggests that adding clearer signs or improving pathway designs could make navigation more straightforward.

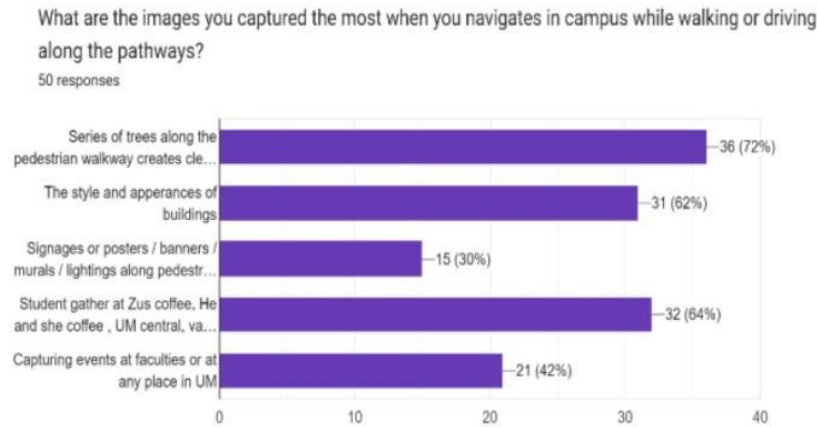


Figure 5: Perceived Image and Identity of UM Campus

Source: Authors (2025)

The survey results show Varsity Lake is a prominent campus feature, with a strong visual image captured in their perceptions (Figure 5). Students found it a focal point for social gatherings and leisure, with fewer green and hardscape elements. The lake's role in campus legibility is significant, as it functions as an edge and landmark, aiding in orientation and enhancing the overall navigability of the campus.

Table 1: Survey findings on campus legibility and wayfinding at Universiti Malaya (n = 50)

Category	Item	%
Legibility	Number of roads/paths	29.7
Challenges		
	Ambiguous intersections	50.0
	Pathway clarity	75.0
	Number of facilities	13.9
	Location clarity	31.0
	Nodes & districts clarity	16.7
	Other	2.7
Legibility Issues	Missing/unclear signage	75.0
	Ambiguous intersections	50.0
	Long/indirect pathways	47.2
	Unclear district definition	44.4
	Insufficient social hubs	30.6
	Lack of lighting/visibility	19.4
	Other	5.6
Overall Experience	Yes (legible)	80.6
	No (not legible)	5.6
	Somewhat	13.9

Note: Results summarize student-reported challenges and issues affecting campus legibility, as well as their overall experience of wayfinding. Percentages reflect proportion of responses per category.

The study shows that students at UM feel a strong sense of belonging to key areas, such as Varsity Lake, UM Central, and Dewan Tunku Canselor (DTC). These iconic spaces, with their distinctive architecture and symbolic importance, act as a point of orientation and connection for students. Engaging in campus life within these spaces positively influences students' sense of connection and belonging to UM, highlighting the role of these spaces in enhancing campus identity and student experience.

Cognitive Mapping Analysis

A study of 50 hand-drawn sketches identified the most frequently noted legible elements on campus. Landmarks, such as Dewan Tunku Canselor, Kolej Pengajian Sains, UM Library, and Chancellery, accounted for 90% of the identified features. Edges, particularly Varsity Lake, were identified as key elements with a 100% recognition rate. Main pathways, such as Jalan Lingkungan Budi from KL Gate and PJ Gate, accounted for 80% of the sketches, indicating their significant role in subjective legibility. Nodes and districts were the least frequently represented elements in respondents' cognitive maps. Further analysis will focus on the specific attributes of identified landmark typologies to understand their influence on campus experience and identity.

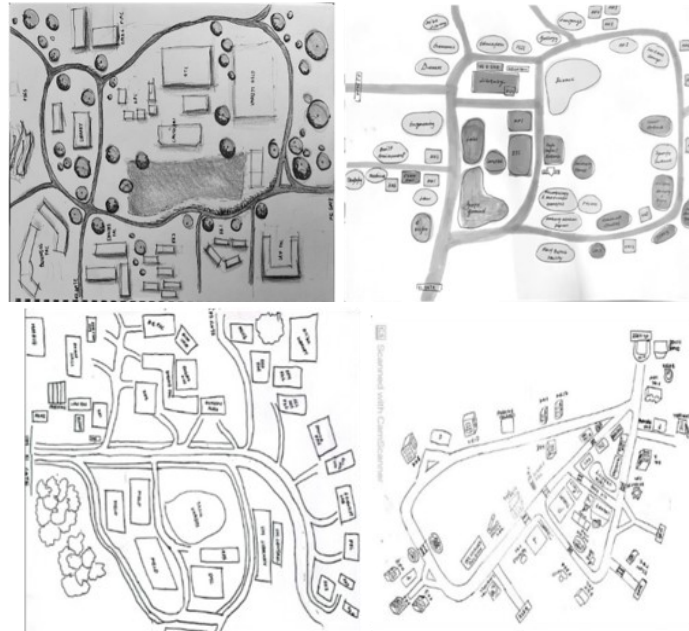


Figure 6: Sample of cognitive mental maps from the respondents
Source: Data collected during fieldwork, Authors (2023)

The study of hand-drawn cognitive mental maps reveals that landmarks, edges, pathways, nodes, and districts significantly influence students' perceptions of campus legibility. These maps, based on cognitive mapping theories, are created based on experiences and interactions, encoding elements like these. Landmarks like Dewan Tunku Canselor and UM Library serve as reference points, while edges define spaces and guide movement. Main pathways like Jalan Lingkungan Budi connect key locations, while nodes and districts are less frequently mentioned. The frequency of these elements in the maps highlights their importance in shaping students' understanding of campus layout, potentially improving campus design and making it more navigable and connected.

The cognitive sketch map shows 42 to 47 legible elements, including pathways, greeneries, faculties, and residential colleges. Pathways were shown with dotted lines, while images of Varsity Lake and UM Campus were captured. Green transitional nodes were identified, and landmarks were identified with red color boxes. Legibility was higher from a student's perspective, and more bus stops were drawn for more transportation nodes.

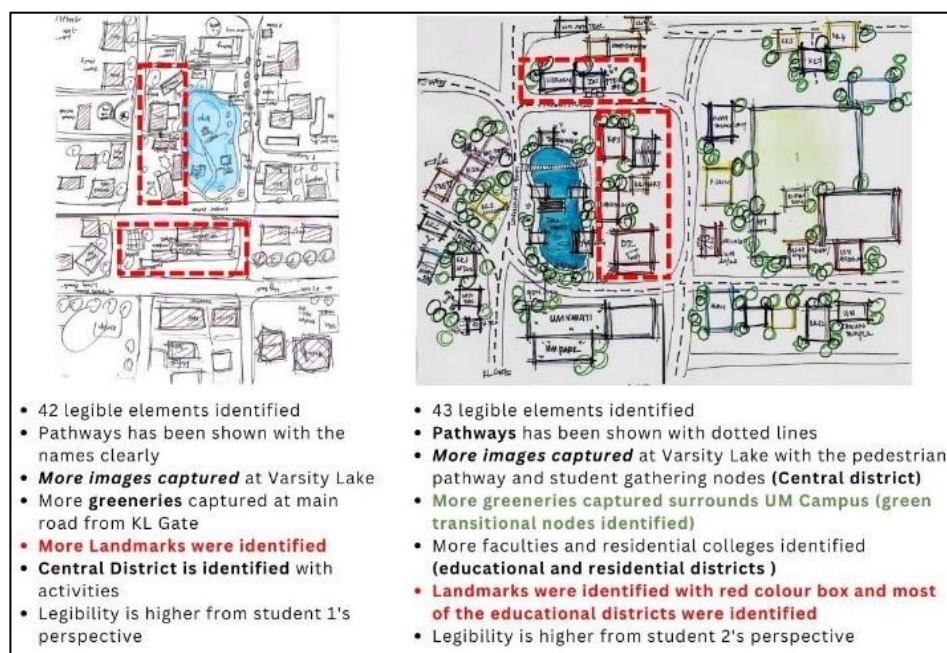


Figure 7: Cognitive Mental Maps Analysis
Source: Data collected during fieldwork, Authors (2023)

The study identifies four **key landmarks** in the study area: **DTC, KPS, UM Library, and Chancellery**. **DTC and Varsity Lake** are the most frequently mentioned landmarks, indicating their significance in the mental mapping of the

area. The central district, including UM Library, UM Central, and popular eateries, serves as a transitional node for student gathering. 72% of participants noted this area as a social hub, and 54% agreed it has the potential to become a designated "student district" in the future. The main road, Jalan Lingkungan Budi, is consistently represented on maps. The path leading to the student plaza is seen as an influential route, enhancing student life and fostering a sense of belonging.

ANALYSIS AND DISCUSSION

Data analysis from hand-drawn sketches from participants was used to visually represent elements from mental mapping. This method is to communicate individual spatial perception and organization. Data from findings indicated that landmarks and edges are crucial for campus navigation, with Varsity Lake, Dewan Tunku Canselor, and the UM Library being the most recalled features, consistent with Lynch's theory on landmark recognition reducing cognitive load. However, while main pathways were consistently mapped, nodes and districts were less represented, suggesting a reliance on a few prominent features for wayfinding, which may pose challenges for new visitors. These findings parallel Esfandfard's (2018) conclusions that wayfinding elements such as signage and directional maps are essential for enhancing urban navigability and mental map accuracy.

Understanding the contribution of the Present Study

Individuals engage with place through cognitive, affective, and behavioural dimensions (Erfani, 2022). Lynch's framework identifies physical elements such as landmarks, paths, edges, districts, and nodes as central to spatial legibility; however, subsequent scholarship has critiqued this approach for insufficiently addressing the relational dynamics among these elements (Lynch, 1960).

Lynch's urban design approach, though foundational, neglects the significance of relational qualities like proximity and visual connectivity in shaping cognitive maps and spatial understanding. This oversight limits its utility in complex urban settings (Zacharias, 1997; Appleyard, 1970). Unlike campuses with robust wayfinding infrastructure, UM's campus lacks consistent signage and clearly defined spatial districts. Studies, such as one on Selcuk University (Deniz & Topcu, 2012) indicate that undefined spaces hinder navigation efficiency, a problem also present in UM's open areas.

Urban legibility depends on both landmarks and the integration of spatial elements. Cognitive maps provide useful insights but are limited by memory distortions (Lopez & Bosco, 2022), as seen in the more coherent maps of long-tenured UM students. Future studies could use GPS or AI validation, while user-centered tools like mobile apps and tactile maps highlight inclusive wayfinding solutions (Swobodzinski, 2021).

CONCLUSION

The study highlighted how imageability and cognitive mapping is crucial for campus navigation at Universiti Malaya. Designed landmarks and pathways are proven to be essential as spatial aids. Navigation challenges such as poor signage, indistinct zones, and inconsistent wayfinding were identified. Cognitive mapping assists students in understanding campus layouts and fostering belonging. Future longitudinal research could examine how extended exposure affects spatial perception and mental campus representations, assessing changes in perceivability, imageability, and legibility. Enhancing campus legibility requires improving navigation and spatial clarity, alongside aesthetic experience and place attachment, to create a more engaging student environment.

This research studied on campus legibility which offers several key recommendations:

1. Implementation of Smart Navigation Systems – Universities should integrate AR-based campus guides and real-time digital maps to assist navigation, particularly for first-year students and visitors.
2. Redesign of Campus Pathways & Signage – Pathways should be visually reinforced with distinct paving, lighting, and signage to enhance clarity and spatial recognition.
3. Creation of Themed Campus Districts – Introducing zoning strategies (e.g., “Academic District,” “Cultural Hub,” “Recreational Green Zone”) can help students develop a stronger mental association with specific campus areas.

Future research has high potential to focus on integrating AI-driven wayfinding tools to analyse real-time student navigation patterns as well as conducting comparative studies across multiple campuses to establish a universal framework for university spatial design.

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DISCLOSURE STATEMENT

The authors declare that there are no potential conflicts that could have influenced the outcomes of this research. The study was conducted independently and exclusively for academic purposes as part of the *Architecture Academic Report (BIA 3022)*.

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