Users’ Legibility on a Proposed Affordable Township for B40 and M40 Income Fishing Community at Kuala Kedah, Malaysia

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Abstract. This study highlights traditional towns and settlements of the fishing communities and their proposed township design. It has proposed one site for the design at Kuala Kedah for the resettlement programme of the fishermen community administered by the Fisheries Development Authority of Malaysia (LKIM). The design will reflect users' recognizable patterns in their contextual urban design elements. Urban design elements are pinpointed in this master plan, referring to the traditional town's setting. The aim is to preserve the socio-economy and tradition of the existing fishing community. This research uses space syntax analysis to examine the level of permeability and wayfinding in justified graph analysis as well as the level of integration and connectivity in axial maps within the urban contexts of the proposed township. The results show that the proposed master plan’s layout plan has very good overall integration with good permeability and connectivity with easy wayfinding in a layout master plan of the designated private and public areas. For this master plan design, applying space syntax is important for evaluating and analyzing the spatial configuration surrounding an area, providing valuable insights into how the layout of urban design elements influences users' perception of spaces.

1 Introduction

1.1 Background

This study investigates users' perception of urban design elements, namely paths, edges, districts, nodes, and landmarks, in the built environment of Kuala Kedah, Kedah (Figure 1) using urban design elements and theories proposed by Kevin Lynch [1]. The paper employs a quantitative research design based on the methodology-justified graph and axial maps. The case study is a traditional fishing village in Kuala Kedah. It has a significant geographical location, and the site is still active fishing villages, which can aid in identifying the underlying urban design elements.

The case study will utilize space syntax theory to evaluate the permeability and wayfinding in the proposed housing master plan layout and ensure the preservation of the local culture and fishing village identity. The paper will also include justified graphs that reflect three distinct spatial categories and territorial types: public, private, and intimate [2]. These categories are associated with activities linked to the outside world, community activities within the residence, and individual activities [3]. This paper focuses on Kuala Kedah (Figure 1), a historic traditional urban township and fishing village in Malaysia that has recently experienced substantial urbanization [4].

The development is mainly due to the construction of housing and public infrastructure to accommodate the growing urban population [5]. The case study in Kuala Kedah (as shown in Figure 1) is an urban area in Peninsular Malaysia with a traditional fishing village settlement that experiences population growth. According to Hassan [6], the settlement encompasses a diverse mix of houses, fishing businesses, fish trade, commercial establishments, governmental facilities, water elements, and religious institutions. The case study is a proposed traditional township at a new area across the Kedah River where the fishing community can live with better standard of living with houses along the riverbank or near the river's mouth and parks their fishing or travelling boats nearby. The township will be designed mostly to house affordable for M40’s (low income families) and B40’s (middle income families) fishing communities. It comprises residential houses, a wet market, workshops, jetties, small-scale business enterprises, an LKIM office, a kinder garden, restaurants and a mosque. The objective of this research is to identify the users' legibility on the urban design element of the proposed township’s master plan of Kuala Kedah.

2 Literature Review

2.1 Background of Case Study, Kuala Kedah

The study is located at 16.18 hectares in the fishing village of Kuala Kedah, situated at the mouth of the Kedah River (Figure 1). It is a parliamentary constituency located in the state of Kedah Darul Aman in the northern region of Peninsular Malaysia. The study area, depicted in Figure 1, consists primarily of homes
of fishing villagers located on land and along the riverbank of the Kedah River. Most fishing communities are middle and low income earners. In Malaysia, the government defines middle income family under category M40s with household income ranging from RM4850 to RM10959 (USD1028 to USD2323) that represents 40% of the total families in this country. Furthermore, B40s mean low income households representing bottom 40% of the total families in Malaysia with household income below RM4849 (USD1027). The existing town of Kuala Kedah also has government offices, workshops, factories, and religious and commercial buildings. It is situated a mere 10 km away from the city center of Alor Setar. It is a sea stop connecting Kuala Perlis, Kuala Jerlun, Tanjung Dawai, and Penang, and was a primary transportation water route to the city center of Alor Setar throughout history until the 1960s before the post-independence development and construction of numerous roads. The improvement and growth in vehicular traffic have brought some positive economic impacts to the fish trade industry, but there still needs to be more concern for urban life, as found in the site of the case study. In his book ‘Cities for People’, Jan Gehl [7] emphasizes integrating pedestrianism into city policies to create liveable, safe, sustainable, and healthy cities for residents. Asphalt roads are established in the villages of the site to ease the ingress and egress, but due to the lack of planning, the walking experience for pedestrians has become less dignified. On the other hand, the emergence of Langkawi Island as duty-free status in 1987 and the construction of a modern jetty by the Malaysian government led to a resurgence in the significance of water access of Kuala Kedah as tourist destinations [8].

2.2 Urban Design

The topography of the site, according to Hassan [9], will determine the settlement pattern, with six different types of settlement patterns being identified in the western coastal region of Peninsular Malaysia: inland water village, outward water village, parallel water village, water village, river-mouth water village, and combined water village [10]. Based on the case study, Kuala Kedah is regarded as a river-mouth water village, with the urban design elements forming continuously along the Kedah River, the main source of income and transportation route.

Despite efforts to preserve traditional ways of life, the capitalist invasion has had a persistent impact, particularly in the fishing industry in Kuala Kedah. Large-scale and modern trawler fishing requires significant capital investment and has replaced small-scale and subsistence inshore fishing methods [11]. This transformation has resulted in the domination of the capitalist economy over the rural Malay peasant economy in Kuala Kedah [12].

The study area (Figure 1) is a proposed township for fishing villagers located on land and along the riverbank of the Kedah River. The Kedah River bounds the area, and a water canal connects to the northeast paddy field. The study area covers 162,248.14 sqm (40.092 acres) and contains a mix of mangrove forest, a Malay cemetery, roads leading to Tok Pasai Bridge, and ‘village (kampung) houses’. However, traditional timber architecture is disappearing as new houses are constructed with modern materials such as concrete, bricks, and steel due to the villagers' desire to upgrade their homes [13]. Furthermore, upon observation, most of the existing timber Malay houses need to be in better condition due to a lack of maintenance.

2.3 Urban Design Elements

Before conducting research methodology and analysis, it is essential to understand the following five design elements from Kevin Lynch's urban design study [1]:

1. Paths: Urban paths are routes people use to move around the city on foot, by car, motorbike, or boat. They should be easily identifiable and connect different functional areas with a sense of continuity. Paths with historical or cultural significance can enhance the city's identity and unity. In the case of Kuala Kedah, the
Kedah River is the main waterway for transportation, while smaller canals serve as secondary access points. The scale and hierarchy of paths should also be considered, with nodes and landmarks providing easy points of orientation [14].

2. Edges: Urban edges can be categorized into legal, physical, and social types. Legal edges create breaks between areas, while physical edges align with buildings. Social edges are pedestrian walkways and river access. Instead of separate barriers, many edges should be seen as a cohesive whole. Paths like arterial roads and riverbanks help orient pedestrians along building facades.

3. Districts: These are specific urban areas sharing similar physical characteristics that can be visually and logically determined, such as the height, size, type, or colour of the buildings or the culture or activity of the area. Various components and elements are visually recognized in a specific characteristic cluster, forming a strong contrast effect. A particular series of clues is required to produce an image of a whole district [15].

4. Nodes are strategic points in the city for people to gather and carry out certain urban activities, highlighting them as unique attractions. Nodes can be associated with landmarks, while paths will lead people to nodes, adding value to the place [16].

5. Landmarks: These tangible objects can be easily identified as essential elements of the place; they stand out from the surrounding character. Possible landmarks could be a bridge, a monument, a vast tree, or a particular building. In other words, landmarks represent the symbolism of a place [1]. By integrating these five urban elements identified by Kevin Lynch—paths, edges, districts, nodes, and landmarks—into the design and planning of a city, urban areas can create walkable environments that enhance the city's livability. Walkability improves access to amenities, promotes physical activity, reduces pollution and congestion, and fosters a sense of community, all contributing to a more enjoyable and sustainable urban experience [17].

3 Research method

3.1 Measurable factors and scales

This paper will analyze urban design elements' measurable factors and scales: path, edge, district, node, and landmark:

1. Path: The paper investigates the path's size, width, and length, which impacts the city's accessibility and connectivity for its inhabitants. In other words, road width (m) and hierarchy are determined in the study to identify the aesthetic value of paths that can reflect and enhance the city's identity. The hierarchy of paths is sorted in Table 1. The road ratio is measured by comparing the road area (m²) to the site's total area (m²).

2. Nodes: In this case study, nodes are assessed through a ratio that considers the node's area (m²) and the number of people involved in its activities. The significance of the activities in the area, such as fish trading for income generation, religious practices, festivals, and cultural and historical events, determines the hierarchy of nodes.

3. Edges: The scale of edges is identified based on the-length (m) and width (m) of the boundary that separates an area's continuity.

-length (m), width (m), and height (m) for physical edges/boundary from building alignment.

-length (m), width (m), and height (m) for social edges, i.e., pedestrian walkway

The hierarchy of edges is established by considering the impact of each edge on the city, starting from the most influential edges to the least significant ones.

4. District: A district is categorized based on its function and the type of buildings. Its density is calculated by dividing its population by its total area (m²) in square meters.

5. Landmark: Factors such as its scale, aesthetic value, and attraction will be considered to determine a landmark's visibility and impact in the city. The most dominant landmark will have the highest level of attraction, which could also have historical significance. The landmark's size, area, and height can be used to calculate its ratio and impact on residents and tourists.

3.2 Permeability and wayfinding

In this case study, permeability and wayfinding are the key urban design concepts. Kevin A. Lynch defined wayfinding as 'a regular arrangement and application of clear sensory clues from the environment' in his influential book 'The Image of the City', which explained how people mentally map and navigate urban environments [1]. One of permeability's critical two functional characteristics is that it allows pedestrians and cyclists from a certain point of the neighbourhood to access facilities, services, and homes, referred to as to-movement. The second one is that pedestrians and cyclists can travel directly through the neighbourhood instead of detaining outside the neighbourhood to reach other communities beyond, referred to as through movement [18].

3.2.1 Justified graph

Justified Graph analysis is a widely recognized technique in space syntax [19 & 20]. The justified graph identifies the spatial elements or access in a layout plan, whether visually or functionally defined, and connects them via relationship (for example, intervisibility, intersection, or adjacency). Then, it performs a graph analysis of the resulting network. This technique examines the range of space depths to determine the level of permeability using justified access graphs [21].

3.2.2 Axial map analysis

The first step to creating a space syntax diagram is to prepare a figure-ground map in AutoCAD with two main layers representing the buildings and streets of Kuala Kedah. Once the map is completed, it is exported as a DXF file and imported into depthmapX version 0.8.0. The building layer is then turned off under the
index tab to convert the drawing into an axial map. To do this conversion, click the button, followed by selecting the internal boundary of the street network structure. After a few seconds, the axial map will appear, colour-coded by ‘Connectivity’, which refers to the number of lines that each line intersects.

**Table 1: Coding and symbol for path**

<table>
<thead>
<tr>
<th>Path</th>
<th>Width</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrance</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Arterial Roads</td>
<td>12m</td>
<td>A</td>
</tr>
<tr>
<td>Collector Roads</td>
<td>9m</td>
<td>C</td>
</tr>
<tr>
<td>Local Roads</td>
<td>6m</td>
<td>L</td>
</tr>
<tr>
<td>End Roads / Cul-de-sacs</td>
<td>6m</td>
<td>E</td>
</tr>
<tr>
<td>Back lane</td>
<td>4m</td>
<td>B</td>
</tr>
<tr>
<td>Bicycle Pathway</td>
<td>1.2m</td>
<td>BP</td>
</tr>
<tr>
<td>Pedestrian Walks</td>
<td>1.2m</td>
<td>PW</td>
</tr>
<tr>
<td>Water Canal (Boat Grade A)</td>
<td>-</td>
<td>WA</td>
</tr>
<tr>
<td>River (Boat Grade B &amp; C)</td>
<td>-</td>
<td>WB</td>
</tr>
<tr>
<td>Jetty</td>
<td>-</td>
<td>J</td>
</tr>
</tbody>
</table>

The symbol for multiple paths is represented by adding a numeric digit by the end of the code assigned.

**Table 2: Layers and Colour Code for Axial Map Analysis**

<table>
<thead>
<tr>
<th>Layers in AutoCAD</th>
<th>Colour code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building</td>
<td>Magenta</td>
</tr>
<tr>
<td>Street/Road</td>
<td>Green</td>
</tr>
<tr>
<td>Water Route</td>
<td>Cyan</td>
</tr>
</tbody>
</table>

The space syntax analysis is still pending. The subsequent step involves creating an axial integration map. Then, click the TOOLS menu and select AXIAL/CONVEC/PESH > RUN GRAPH ANALYSIS. Choose the default analysis, which is the radius n of the axial map. The acronym ‘HH’ stands for Hillier and Hanson, who developed the concept of integration as described in the Social Logic of Space [19]. The axial map displays path patterns through a colour code which indicates the hierarchical order of street patterns, which are listed at the bottom of the figure or as follows [22]:

**Table 3: Colour code indicates the hierarchical order of street patterns in an axial map.**

<table>
<thead>
<tr>
<th>Colour Code</th>
<th>Colour Range</th>
<th>Level of path permeability</th>
<th>Level of Wayfinding</th>
<th>Path category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Public</td>
<td>Very Easy</td>
<td>Arterial Roads</td>
<td></td>
</tr>
<tr>
<td>Orange</td>
<td>Public</td>
<td>Not Easy</td>
<td>Collector Roads</td>
<td></td>
</tr>
<tr>
<td>Yellow</td>
<td>Private</td>
<td>Not Easy</td>
<td>Local Roads</td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td>Private</td>
<td>Very Easy</td>
<td>Local Roads, Back lanes</td>
<td></td>
</tr>
<tr>
<td>Cyan</td>
<td>Private</td>
<td>Not Easy</td>
<td>Bicycle Pathway, Pedestrian Walks</td>
<td></td>
</tr>
<tr>
<td>Blue</td>
<td>Private</td>
<td>Very Easy</td>
<td>End roads, cul-de-sacs</td>
<td></td>
</tr>
</tbody>
</table>

3.2.3 Cross Analysis from Results Analysis of Justified Graph and Axial Map

The justified graph method enables the measurement of paths by labelling and plotting each node. A chart illustrates the hierarchy of nodes from 0 to n based on their order, with higher-order paths having higher levels. The justified graph depicts two lines: black lines for node linkage and red dashed lines for vertical circulation. The master plan is analyzed to determine the depth level of the permeability study for the case study, with all nodes labelled. Furthermore, the colour codes from space syntax analysis can be used to distinguish paths from public to private, and all lines on the axial map are named based on their street names. Data from the justified graph and space syntax analysis is tabulated to compare the level of permeability, wayfinding, and resulting path similarity.

4 Result of analysis

4.1 Result of justified plan graph and urban design element

4.1.1 Entrances

The main entrance to the site (as shown in Figure 2) is accessed from Marina Harbour Road from Tok Pasai Bridge, serving both locals and tourists. Entrance 1 (+1) is the primary entrance for fishermen to access the sea by boat and provides access to the affordable and mid-end residential district. The road is the sole route for entering or exiting the villages. Entrance +2 is the entrance to the most significant residential zone, consisting of mid-end apartments, terraces, townhouses, and high-end bungalows. Entrance +3 is the gateway to District 1, the commercial and amenities district primarily catering to the residents of the proposed master plan. This district features the Commercial Hub, Experience Hub, and Community Center, which
includes facilities such as a Police Station and Wet markets. The hierarchy order of the entrances is Entrance 1 (+1) > Entrance 2 (+2) > Entrance 3 (+3). The justified graph method enables the measurement of paths by labelling and plotting each node.

4.1.2 Nodes in Justified Plan Graph

The overall justified graph's pattern is unusual because it features dual entrances, one from the landside (Tok Pasai Bridge) and the other from the waterside (Kedah River). Based on the overall justified graph for the proposed township (as shown in Figure 3):

Nodes in the Justified Graph (as shown in Figure 3) are:

- Node 1 functions as a public square located within the medium-cost apartment complex. It is a common gathering space for fishermen before and after work and a shared space within the apartment community.
- Node 2 is a resting port specifically designed for fishermen. It features a small artificial island where fishermen can gather, socialize, and converse.
- Node 3 is a nature-centric node that attracts individuals who enjoy immersing themselves in green spaces. It offers a serene and natural environment.
- Node 4 is dedicated to public amenities, including sports courts, providing recreational facilities for the community's use.
- Nodes 5 and 6 are private jetties for high-end residents to dock boats. These areas also serve as waterfront walking zones, popular for leisurely walks, especially during the noon hours.
- Node 7 represents the commercial center, drawing people to its retail and commercial establishments.
- Node 8 encompasses the Community Center, which includes a fishermen's exploration center. This attraction attracts visitors from outside the community interested in exploring the fishermen's way of life.
- Node 9 features a floating public square for religious and ritual activities and festivals. This node acts as a central gathering point for such events.

4.1.3 District in Justified Plan Graph

Districts in the Justified Graph (as shown in Figure 3) are:

- District 1 is a fishing amenities district with LKIM and a jetty. The place where the fishermen use this area prepares their boats before going out to the sea.
- District 2 is a residential townhouse; most residents are fishermen who quickly access LKIM.
- District 3 is a residential district with Modern Architecture where concrete houses are affordable-cost medium-rises.
- District 4 services district, which comprises underground STP and water tanks.
- District 5 is a greeneries zone where trees, water retention ponds, and parks reside.
- District 6 is commercial; amenities and facilities are the primary districts for the locals living in the proposed master plan. The Commercial Hub, Experience Hub, and Community Center comprise Police Station and Workshops.
- District 7 is a residential district with Modern Architecture comprised of townhouses.
- District 8 is a residential district with Modern Architecture comprised of medium-cost apartments.
- District 9 is a residential district with Modern Architecture comprised of medium-cost terrace houses.
- District 10 is a residential district with Modern Architecture comprising high-end detached houses and attractions for visitors from outside the community interested in exploring the fishermen's way of life.

4.1.4 Paths

In the proposed master plan, most buildings have entrances on land, but there are also waterside structures like the LKIM building accessible from both land and water routes. Thus, visitors and residents can choose between waterways and land access. The path pattern and navigation to districts and nodes on land are straightforward due to the three main arterial roads connecting them. The overall justified graph analysis shows that visitors tend to follow paths toward public areas while residents opt for more private routes. Both visitors and residents can access public spaces and exit the site through either land or waterway options.

Table 4. The table compares each type of road path in the case study.

<table>
<thead>
<tr>
<th>Type</th>
<th>Total Road</th>
<th>Road Width (m)</th>
<th>Total Distance (m)</th>
<th>Percentage Total Distance (Road Distance/Total Road Distance) x 100%</th>
<th>Ratio of Road Type (Numbers of Road/Total Roads)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road Reserve (Marina Harbour Road)</td>
<td>1</td>
<td>20</td>
<td>1102.80</td>
<td>5%</td>
<td>0.032</td>
</tr>
<tr>
<td>Arterial Roads</td>
<td>3</td>
<td>20</td>
<td>650.50</td>
<td>3%</td>
<td>0.097</td>
</tr>
<tr>
<td>Collector Roads</td>
<td>6</td>
<td>15</td>
<td>902.50</td>
<td>4%</td>
<td>0.194</td>
</tr>
<tr>
<td>Local Roads</td>
<td>11</td>
<td>12</td>
<td>2735.50</td>
<td>11%</td>
<td>0.355</td>
</tr>
<tr>
<td>Bicycle Pathway, Pedestrian Walks</td>
<td>3 2-3</td>
<td>18760.05</td>
<td>77%</td>
<td>0.097</td>
<td></td>
</tr>
<tr>
<td>End roads, back lanes and cul-de-sacs</td>
<td>7 12</td>
<td>106.68</td>
<td>0.4%</td>
<td>0.226</td>
<td></td>
</tr>
</tbody>
</table>
In the case study, the river (MB) plays a crucial role as the primary mode of transportation and a significant source of income for the fishermen. On the other hand, the Marina Harbour Road serves as the critical land pathway in the study, leading to three entrances to the site. Most wayfinding levels are rated as easy due to the convenient connection of jetties, linking the river to various districts. Waterside facilities such as the mosque, LKIM, wet market, and Discovery Center are easily accessible. Despite being concealed by the mosque, LKIM, wet market, and Discovery Center are various districts. Waterside facilities such as the mosque, LKIM, wet market, and Discovery Center are easily accessible.

The bicycle pathway and pedestrian walks are interconnected along the entire outer river edge. Then, there are four pedestrian walks, which lead the visitors to the waterfront. PW1, PW2, PW3, PW4. Then, four bike lanes are connected to the site BP3-BP1-BP4, where BP2 is a private bike lane. PW1, PW2, PW3, PW4, then connect to the waterfront. PW1, PW2, PW3, PW4. Then, four bike lanes are connected to the site BP3-BP1-BP4, where BP2 is a private bike lane.

### Table 5. The colour code indicates the hierarchical order of the path in Figures 2 and 3.

<table>
<thead>
<tr>
<th>Path Category &amp; Color Code</th>
<th>Level of Permeability</th>
<th>Level of Wayfinding</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial Roads (Red)</td>
<td>Public</td>
<td>Very Easy</td>
<td>There are three main Arterial roads. A1 &gt; A2 &gt; A3</td>
</tr>
<tr>
<td>Collector Roads (Orange)</td>
<td>Public</td>
<td>Very Easy</td>
<td>There are six main collector roads. C1 &gt; C2 &gt; C3 &gt; C4 &gt; C5 &gt; C6</td>
</tr>
<tr>
<td>Local Roads (Yellow)</td>
<td>Public/Semi</td>
<td>Easy</td>
<td>There are 11 collector roads. L1 &gt; L2 &gt; L3 &gt; L4 &gt; L5 &gt; L6 &gt; L7 &gt; L8 &gt; L9 &gt; L10 &gt; L11</td>
</tr>
<tr>
<td>Bicycle Pathway, Pedestrian Walks (Green)</td>
<td>Public/Semi</td>
<td>Easy</td>
<td>The bicycle pathway and pedestrian walks are interconnected along the entire outer river edge. Then, there are four pedestrian walks, which lead the visitors to the waterfront. PW1, PW2, PW3, PW4. Then, four bike lanes are connected to the site BP3-BP1-BP4, where BP2 is a private bike lane.</td>
</tr>
<tr>
<td>End roads, back lanes, and cul-de-sacs (Cyan)</td>
<td>Semi/Public/Private</td>
<td>Not Easy</td>
<td>There are seven end roads/cul-de-sacs. E3&gt;E5=E4=E6=E1&gt;E2=E7. E3 is the end road of service road to the services district comprises underground STP and water tanks. E2, E7, E6 are the cul-de-sacs within the residential district.</td>
</tr>
</tbody>
</table>

### 4.1.5 Edges

In the master plan (Figure 6), the Tok Pasai Bridge is a connecting point between Kampung Tengah Village and the opposite side of the site, dividing the area into two parts. A solution has been proposed to incorporate green areas and recreational spaces beneath Tok Pasai Bridge. There are several edge types indicated in the proposed master plan:

- **Edge 1 (Riverside Lines):** This edge serves as the eastern boundary for the master plan and can also be considered the critical edge that demarcates the area along the riverside. It provides a visual and physical separation between the land and the river, defining the boundary between the built environment and the natural water body.

- **Edge 2 (Water Canal Line and Highway):** It creates the western and northern boundary, the water canal line and Marina Harbour Road form this edge. Its function is like Edge 1, delineating the area along the water canal. It marks the boundary between the built environment and the water feature, contributing to the overall character and layout of the master plan.

- **Edge 3 (Arterial Road - A2):** This edge corresponds to the arterial road, identified explicitly as A2. Its primary function is establishing a boundary between the residential and commercial areas within the master plan. The road serves as a major transportation route, providing connectivity and accessibility while also creating a clear division between these distinct land uses.

- **Edge 4 (Vehicular Access):** This edge represents the area designated for vehicular access. It controls and directs traffic flow within the master plan. A clear delineation/southern boundary is established by defining the affordable residential zone's boundaries. The hierarchy of the edges can be described as Edge 1 (Riverside Lines) > Edge 2 (Water Canal Line and Highway) > Edge 3 (Arterial Road (A3)) > Edge 4 (Vehicular Access).
Fig. 2: Layout Master plan of The Township with Coding of Entrances, Paths, Nodes, Landmarks, Districts, and Edges

Fig. 3: Justified graph illustrating entrances, paths, nodes, landmarks, and districts
Figure 4: Axial graph showing connectivity with coding of entrances, paths, nodes, landmarks, districts and edges.

Figure 5: Axial graph showing integration with codings of entrances, paths, nodes, landmarks, districts and edges.
4.1.6 District

The most significant district within the master plan is District 1. District 1 is a fishing amenities district, housing essential facilities such as LKIM and a jetty. Fishermen gather to prepare their boats before heading to sea in this area. It has become a daily destination for fishermen and holds importance to their livelihoods. Other than District 1, District 5 is a zone dedicated to green spaces featuring trees, water retention ponds, and parks. It acts as a green lung for the master plan, providing environmental benefits such as improved air quality.

The inclusion of retention ponds helps prevent flooding within the overall development. District 6 functions as the commercial, amenities, and facilities district, catering to the residents of the proposed master plan. It hosts key establishments like the Commercial Hub, Experience Hub, and Community Center, which includes facilities such as a Police Station and Workshops. This district has become a focal point for important festivals, religious activities, and cultural events. It also has the potential to attract tourists who wish to explore the vibrant township.

4.1.7 Nodes

There are 11 nodes within the site, with Node 11 being of paramount importance as the primary jetty for fishermen, known as the LKIM jetty. It is the busiest hub where fishermen unload their catch and receive rewards, contributing significantly to their income. Node 10, a public jetty, is frequented by residents in affordable and medium-cost housing areas, making it a lively and popular spot within the community.

4.1.8 Landmarks

Primary Landmark 2 holds significant importance as it is a floating public square dedicated to religious and cultural activities. It is an architectural design, and iconic structures make it visually appealing, creating a focal point that captures the attention of observers, particularly visitors entering the site via Tok Pasai Bridge. Primary Landmark 1 LKIM building, it not only serves as a prominent visual feature but also functions as a new LKIM observing jetty, making it an attraction point within the area. Secondary Landmark 02 is the spiral elevated pedestrian and bike lane, designed to capture attention and draw viewers' gaze, particularly from the Kedah River and Kampung Tengah. Its unique and visually striking design adds visual interest to the surroundings.

Lastly, Secondary Landmark 1 refers to the commercial center, distinguished by its visually appealing architectural elements. The center's design aims to attract people to its retail and commercial establishments, making it an engaging and visually captivating area. The hierarchy of the landmarks can be described as: Primary Landmark 2, Primary Landmark 1, Secondary Landmark 2 and Secondary Landmark 1 respectively.

5 Discussion

5.1 Path

The justified graph and space syntax diagram provide insights into the hierarchy of entrances within the master plan. The connectivity of the vehicular access, specifically Marina Harbour Road originating from Tok Pasai Bridge, significantly impacts the entrance hierarchy as it serves as the primary access point to the site; each district is led by three different arterial roads, A1, A2, and A3. The residential areas are highlighted in yellow to red, indicating that connectivity for the residents is prioritized.

Additionally, water access and the jetty are crucial in determining the hierarchy within each district. The design and specifications of the arterial, collector, and local roads adhere to proper standards, ensuring smooth vehicular movement and delivery of goods and services within the master plan [23]. The color code utilized in the space syntax diagram effectively reflects the functional aspects of each district, further enhancing the understanding of their roles and importance.

Based on the justified graph (Figure 3), the axial map showing connectivity (Figure 4) and integration (Figure 5) provides insights into the hierarchy of entrances within the master plan. The connectivity of the vehicular access, specifically Marina Harbour Road (highlighted in orange and red in Figure 5) originating from Tok Pasai Bridge, significantly impacts the entrance hierarchical importance as it serves as the primary access point to the site. The arterial road towards affordable residential areas and the public jetty are highlighted in red and orange, indicating that the axis path toward Kedah River is prioritized.

Additionally, water access and the jetty are crucial in determining the hierarchy within each district. The design and specifications of the arterial, collector, and local roads adhere to proper standards, ensuring smooth vehicular movement within the master plan. The road towards the public jetty perpendicular to Kedah River is red coded, reflecting the district's functional aspects, further enhancing the understanding of the connectivity and importance of the public jetty. However, the depth level of 3 or higher in the residential area suggests a deliberate emphasis on providing path privacy for the residents in these areas. The use of red and orange colours to highlight the residential zones further reinforces this prioritization of connectivity.

5.2 Edges

The proposed master plan consists of four edge types. Edge 1 acts as the eastern boundary, demarcating the area along the riverside and separating the built environment and the natural water body. Edge 2 is the western and northern boundary, delineating the area along the water canal and Marina Harbour Road. Edge
3 corresponds to the arterial road (A2), establishing a boundary between residential and commercial areas. Edge 4 represents the designated vehicular access area, controlling traffic flow and defining the southern boundary of the affordable residential zone. These edges define the master plan's boundaries, character, and functionality. Edge 1 and Edge 2 are firm edges that play crucial roles in defining the boundaries. Edge 3 is the arterial road (A2), which functions as a subtle boundary that defines the specific functions of the respective districts. Edge 3 did not physically divide the site in half and still effectively distinguishes between two areas.

5.3 District

The districts within the master plan are satisfactory. District 1 is the most significant as it serves as fishermen's primary access point via land and water routes. District 1, which encompasses the LKIM fishermen's amenities, is located at a depth level of 2 within the master plan. The proximity of residential District 2 to District 1 ease accessibility of residents from District 2. Based on Figure 4 and Figure 5, for fishermen residents, the result in a higher level of public exposure, connectivity, and integration within the residential area can be advantageous for their convenience and accessibility, as it indicates a more localized structure.

5.4 Nodes

The nodes in the site are strategically positioned to attract local people/fishermen and outside visitors, focusing on their proximity to the river. The space syntax analysis shows that the colour code at the masjid (N8) areas ranges from orange to red, indicating that the level of connectivity is higher compared to the road within the fishing commercial area. However, the axial map may only partially indicate that the nodes are gathering places for people getting off boats. Nevertheless, the nodes' strategic location near the Kedah River remains beneficial. For instance, node 11 (LKIM jetty) is a crucial and easily accessible primary node in the master plan. Then, node 1 is considered a relatively weaker node than others as it primarily serves as a private gathering spot within the residential area. Its limited accessibility and exclusive nature make it less prominent than other nodes within the master plan.

5.5 Landmarks

The overall results are very good with the four landmarks in the master plan which consist of three functional buildings, proximity to jetties for water access points that enhance their prominence. Primary Landmark 1 and 2, the floating public square, and the LKIM building will become a reference point of the place within the proposed master plan that attracts people from Tok Pasai Bridge's main road. Secondary Landmark 2 is the weakest. It is situated in the blue zone (according to space syntax analysis), indicating that it may pose challenges in terms of accessibility.

6 Conclusion

In conclusion, the justified graph and axial map analysis provide valuable insights into the urban design elements of the proposed housing master plan in Kuala Kedah. The findings show that the proposed master plan’s layout plan has very good overall integration with good permeability and connectivity with easy wayfinding in a layout master plan of the designated private and public areas. The study highlights the significance of the connectivity of vehicular access, the prioritization of path privacy in residential areas, the role of water access and the jetty, and the proper design of arterial roads and local roads. The contributions of the analyzed urban design elements, axial map, and justified graph in the proposed master plan include prioritizing path privacy, creating distinct edges, establishing well-defined districts, strategically placing nodes, and incorporating functional landmarks.

These elements contribute to the overall functionality, accessibility, and aesthetic appeal of the master plan. An example of a highly effective urban design element is Edge 1, which serves as the eastern boundary along the riverside, making it a prominent and well-integrated feature within the urban design. Node 1 besides functions as a private gathering spot within the residential area. Its limited accessibility and exclusive nature result in less prominence than other nodes.

Limitations of the study include its focus on the proposed master plan in Kuala Kedah, which may need to fully capture the diversity of urban design elements in water contexts. Future research studies should consider expanding the scope to include different master plan routes and analyze their impact on user perception. Additionally, further investigation is needed to address accessibility challenges in certain areas and propose solutions to enhance the overall urban design of the master plan.

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