A study on urban spatial patterns of riverside settlement: a case study of Musi Riverside, Palembang

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Abstract. The riverside settlements in Palembang are located in wetlands in the form of tidal swamps. This natural condition affects the formation of the urban spatial patterns because all local people activities are carried out on swamp land. Studies on the urban spatial patterns of riverside settlements are intended to obtain the consideration in wetland urban spatial planning, especially in Zoning Regulations, as a tool in building permission. The research method was a case study method consisting of field research and questionnaires distributed to the local community. The location took place in three riverside settlements. The analysis used descriptive analysis for field survey result and likert scale measurements for questionnaire result. The analysis showed that the riverside settlements had unique characteristics because most of the people activities took place above the water. The boundaries of neighborhood units were formed by rivers and roads. The patterns of villages and buildings had two orientations: the road and to the river. The urban spatial patterns in riverside settlement consisted of three patterns: linear patterns, grid patterns, cluster patterns and combinations, due to the natural conditions and the limitations of the material used to form the structure of the road. Buildings and roads in the area were made above the water (on stilts structure), and the height of the stilts considered the water level at the highest tide. The results of this study could be used as consideration in determining the design criteria of urban spatial planning in the riverside settlement.

Keywords: spatial patterns, settlements, river banks

1. Introduction
Palembang municipality is the capital of South Sumatera Province. Palembang is divided into two areas by Musi River, namely Seberang Ulu and Seberang Ilir. There are many heritage settlements along the riverside, since the river was a main transportation at the past. The riverside area grows and develops into big settlement with high population growth, both from local people and immigrants. These riverside settlements cover a large area and the fast development of the settlements tends to be slum area. In Palembang there are about 59 urban kampongs that are categorized as slum areas.

Two of the riverside settlements are 3-4 Ulu and 35 Ilir. Each area represents settlements in Seberang Ulu and in Seberang Ilir. 3-4 Ulu represent Seberang Ulu riverside settlements and 35 Ilir represent Seberang Ilir riverside settlements. Those two riverside settlements have the similar physical characteristics as they are located on the Musi riverside and affected by tides. The two settlements are also included the old settlements. In 3-4 Ulu, many migrants built their houses leading to the river banks connected with existing settlements. New settlements that were built by migrants tend to be
irregular and in bad condition. While in 35 Ilir, only a few migrants built their houses in this area, but the settlements also became irregular due to the limited land.

The urban design of the riverside settlements requires various considerations from various aspects. Riverside environment is one of the important aspects that should be considered in urban designing and planning [1][2][3][4]. Bayu[5], Qureshi[6] and Shams [7] argue that the socio-cultural aspects of society also influence the urban design and planning. The consideration of physical aspects and non-physical aspects in determining urban design criteria will improve the structure of performance. This research will be used to determine urban design criteria for riverside settlements on wetlands, especially on the riverbanks of Musi River. This urban design criteria then became one of elements for making urban spatial models. The criteria can also be used in determining special rules in Zoning Regulations as a tool in spatial patterns and building permits regulation. In zoning regulations there are several important elements to be regulated related to the sustainability that is affected by tides. These elements include land use, building mass management, circulation and open space[8][9][10][11].

2. Methods
The research method was a case study method consisting of field research and questionnaire distribution to the local community. The location took place in two riverside settlements: 3-4 Ulu and 35 Ilir. The analysis used descriptive analysis for field surveys result and likert scale measurements for questionnaire result.

3. Discussion
3.1. Physical and Natural Conditions of Riverside Settlements
Riverbank settlements in Palembang City have special characteristics, because most of the area is covered by tidal land. The tidal area is found almost along the Musi riverbanks, especially in Seberang Ulu settlements. Two of the tidal settlements at Musi riverside are on 3-4 Ulu and 35 Ilir. The water from the rivers can reach more than half of the riverside settlement areas. The tides has a certain cycle, in which the highest tide is every five years. The local people in tidal settlements have their own uniqueness because all activities are adjusted to the natural condition.

This natural condition affects the formation of the urban space. Urban rivers have a key ecological and social role in a wider urban system. This ecological function will be included as one of the urban design criteria. This natural condition also affects the shape of urban space. Population activities in public spaces have limitations, because there is few space that can be trampled on limited spaces for circulation. This is in accordance with Doxiadis’s theory that the form of settlement patterns is usually the result of various factors that shape it [12][13]. In other words, the form of settlements consists of content, namely humans both individually and in society and containers, namely the physical environment of settlements.

Physically the boundaries of the riverside settlements in Palembang are main road and the Musi river. Between the road and the river there are several small rivers that are also used as administrative boundaries (figure 1).
In riverside settlements, the buildings located on the main road are mostly landed houses, while the buildings on the setback are stilt houses, and the height of the stilts is adjusted to the highest water tide level. The left and right sides of the main road are mostly reclaimed and the buildings are usually used as education facilities, health facilities, religious facilities, stalls and shops (figure 2).

In general, the physical conditions in riverside settlements are: (1) riverside settlements have physical borders that include main roads and large rivers, and small rivers between them; (2) the distance between the main road and the river is around 200-400 meters; and (3) The area close to the road has been reclaimed while the area on the second layer is still a tidal swamp. These physical constraints will be a limitation in constructing the spatial pattern of urban design.

3.2. Social Aspects
Related the social aspect, there are significant differences between local people of the settlements in Seberang Ulu and Seberang Ilir. In the Seberang Ulu settlements, there are many migrants from the area around the Palembang city, as well as the indigenous population. Most indigenous people occupied old houses from generation to generation, while migrants built their houses towards the
riverbank by connecting pathways to the existing road environments. Meanwhile in Seberang Ilir, the majority of the population are indigenous people who have lived in the area for a long time. Beside that, there is a different level of education and livelihoods. Most residents in Seberang Ulu have low education level and work in the informal sector. In contrast, in Seberang Ilir they have higher education level and people work in the formal sector. These two differences influence the physical forms of the settlements. This is related to Doxiadis's theory that the urban pattern form is usually the results of various factors that form it [14].

From time to time, in the process, the local population has begun to adjust the physical conditions of nature in forming the riverside settlement. It is seen by the way they built their houses. They built their houses on stilts, and because they have limited open space, they also add the veranda in each house. Aside from being a transitional space, this veranda also functions as a socialization space with neighbors. Some residents also use the veranda as a workspace.

3.3. People activities
Population activities in both research locations can generally be divided into three categories, namely daily activities, optional activities and social activities [15]. The daily activities generally include three groups of main activities, they are: (1) Daily activities, such as cooking, eating, sleeping, receiving guests, gathering with family, washing, drying, bathing; (2) Socializing with neighbors and community activities; and (3) Ceremonial activities, such as weddings, circumcisions, marriage. Beside that, in Seberang Ulu settlements local people also carry out economic activities around their homes, such as making crackers and crafts from nipah leaves. These activities take place in public spaces, such as drying crackers on the roadside or in spaces between buildings. Beside those activities, local people also carry out activities in their neighborhood to earn income, such as selling, fishing, making boats and others. These activities show that there is a strong connection between the daily people activities and their settlements, especially on the riverbanks.

The settlement environment is the most widely used by women for social interaction. Therefore, urban spaces in residential areas must be comfortable to fulfill those needs. In the riverside settlement, urban spaces also need to set up the space for social interaction activities, especially by women who spend most of their daily time around their homes. The design of the urban space must consider these requirements.

3.4. Settlement pattern
The physical boundaries of each residential unit are bordered by the main road, a large river and two small rivers, which lead to a large river. This is what distinguishes riverside settlements from other settlements in Palembang. Riverside settlements have begun to change the orientation from river to land [16]. This also influences the settlement pattern. However, in two case studies, there was still a strong connection between the settlement area and the river.

From the results of the field survey, the spatial pattern in 3-4 Ulu and 35 Ilir had almost similar patterns. The spatial patterns in both settlements could be divided into three patterns: linear patterns, grid patterns and cluster patterns. The formation of three patterns showed that they were organic and unplanned. People built their houses in several layers, starting with the main transportation channel. These patterns were the same as the characteristics of traditional settlement patterns.

The linear, grid and cluster patterns could be found on 3-4 Ulu and 35 Ilir but they were in irregular patterns influenced by the wood material for the path of movement. This wooden walkway created a straight pattern and interconnection that formed a linear pattern, grid pattern and cluster pattern or combination between them. The wooden walkway on stilt structure was then turned into a reinforced concrete structure, also on stilts.
3.4.1. **Linear pattern**
The most common urban space pattern in riverside settlements was linear pattern. It is also commonly found in a number of traditional settlements [17][18]. The linear pattern followed the path of the roads and alleys. This pattern has actually been used for a long time in swamp settlements, because the growth of settlements followed existing roads or connected to existing roads. The house orientation was to the circulation path but sometimes the pathway passed next to a house.

The linear pattern was divided in two patterns: a one side linear pattern and a two-sided linear pattern. In the one side linear pattern, the building is on one side of the road, whereas in the two-sided linear pattern, the building is on both sides of the road. This linear pattern is widely used in riverside settlements where the straight pathway connects one to another and also connects to the river.

3.4.2. **Grid Pattern**
Grid pattern is an extension of linear pattern. The formation of this pattern is a combination of several road lines (main road and alleys) that form a grid pattern. This pattern is more efficient in land use and circulation. In riverside settlements, this grid pattern connects the main road to the river. At the meeting point between the road and the river, there is a boat dock. The connection between the land and river circulation paths gives a unique pattern of riverside settlements. The existence of boat dock at each end of the meeting point reflects that the people of the riverside settlements still utilize the river as one of the transportation modes.

3.4.3. **Cluster Patterns**
This pattern is usually used in small environmental units (figure 3). This culter pattern is made by a large family group who want their family to live not far from each other. In the middle of a house group, usually there will be open spaces that become communal spaces. The open spaces have many functions, including a space for socialization and ceremonial space. Houses in this pattern surround open spaces and face open spaces as the front. This grouping pattern usually tends to be closed and access to other residential units is limited.

![Figure 3. The spatial patterns of riverside settlement](image-url)
3.5. The Settlement Orientation
Both in 3-4 Ulu and 35 Ilir have two orientations: landed orientation and river orientation. Settlements with landed (road) orientation are usually on the edge of a large road with several characteristics: (1) the main road is the main orientation of all walkways and buildings; (2) the buildings on the back layer are connected to the road with a path formed by wood, which was later renovated into a concrete bridge while still using the stilt structure; (3) The settlement pattern uses a combination of grid and linear patterns; and (4) there is only few dependance to the river, especially in terms of transportation.
Settlements with an orientation to the river are the beginning orientation settlement in Palembang, because once the river was the main transportation modality. In this type, the building orientation is to the river and usually in each environmental unit has a small dock at the meeting point between alleys and river, as a place for boat.

3.6. Element Urban Spatial Pattern
Elements of urban spatial in riverside settlements include land use, building mass, circulation and open space. These elements are different from Lisa [19] and Qomarun [9], but in line with the theory of Shirvanii[8] who called them physical elements of the city.

3.6.1. Land use
Land use is the basic element for urban design, because space allocations for activities will be based on land use arrangements. Land use regulation cause more efficiency and effectiveness of land use, considering that urban land has an increase in value every year. To achieve effective land use, it is necessary to apply land use diversification. Of course the dominance of land use still refers to urban planning of Palembang City.
Diversification in land use allows for the flexibility of activities permitted in the area. As an area designated for settlements, other activities that are permitted there are those that support settlement activities. Structuring land use also considers the need for space for the activities of its population. For example, open space also needs to be allocated specifically to meet the needs of the population for social interaction. This open space can be placed on the meeting point the road and alleys or at several meeting nodes between the path and the riverside area.
From the results of questionnaire, there were differences in people opinions about land use. At 3-4 Ulu land use was in second rank after circulation, while at 35 Ilir land use was the most important thing in urban design. This is understandable because in 3-4 Ulu circulation is the most important problem for increasing settlement access. Whereas in 35 Ilir land use is considered important because it is the basis for the activities on it.

3.6.2. Building Mass
The intensity of the building analysis is the most important in building mass regulation, as well as the analysis of building structure, analysis of building distance and the building orientation pattern that is associated with the existence of roads and rivers. Calculations of building distance include the distance between buildings with each other, the distance between buildings and roads, the distance between buildings and paths and the distance between buildings and rivers.
The distance between buildings is very tight and so it causes a lack of healthy living environment. This is because under the house that is exposed to the sun becomes moist, so many mosquitoes inhabit the underwater area. This is also exacerbated by unhealthy ways of life, such as throwing garbage or household waste under the house.
In order to set up the building distance, there are number of points to be considered: (1) Safety against fire hazards, because most of the houses material use flammable wood; (2) The natural lighting from the sun that needs to be calculated so that the underside the house remains exposed to sunlight and not moist; (3) Building thickness arrangement, because it will affect the irradiated area and the area
covered by shadows; and (4) Arrangement of the height of the building stilt structure, because it will affect the area under the sun. Setting this stilt height is also influenced by the height of the water level at the highest tide.

The distance between buildings and rivers follows the rules of river border boundaries for residential areas, about 15 metres from the river bank at the highest tide for large rivers. While for small rivers, the distance buildings and the river banks is at least 3 metres from the edge of the embankment. The river is used as a waterfront and not the backyard of the building. Building arrangements will reduce interference with the river itself. Until to date the river, which initially became the front of the building, has turned into the back and tended to become slum. The expansion of the building also caused the river banks to become unclear.

3.6.3. Circulation
In riverbank settlements, there are two main circulation paths: road and river paths. These two circulation paths are usually connected with small roads or alleys. At each meeting of alleys and river usually there is a boat dock and stairs to go down to the river. Local residents still often use the river as a toilet facility (bath, wash, toilet) on the stairs. There is strong connectivity between road and river path. Changes in modes of transportation from river transportation to road reduce the river functions as a circulation path. But in riverside settlements, the river is still an alternative circulation path.

3.6.4. Open space
Open space in riverside settlements is different from landed settlements. Open space includes movement paths (roads, bushes, rivers) and spaces between buildings. Open space, which is a public space, is mainly located in an area that can be 'trampled', meaning that there are limited spaces for open spaces. Open spaces in this settlement include main road and alleys on stilt structures. Other open spaces are spaces between buildings in tidal area in which during the tidal season it is flooded and during the dry season it becomes 'land'. To fullfil the need of open space, sometimes local people try to 'widen' the land, by adding a platform from some wood on stilt. Besides that, the veranda also becomes an important part of the house as a place to socialize with their neighbors.

4. Conclusion
The boundaries of neighborhood units are formed by rivers and roads. The pattern of villages and buildings has two orientations: to the road and the river. The urban spatial patterns in riverside settlements consist of several patterns. They are linear patterns, grid patterns, cluster patterns and combinations, due to the natural conditions and the limitations of the material used for the road structure. Buildings and roads in the area are made above the water (on stilts structure), and the height of the stilts considers the water level at the highest tide.

Four elements of urban spatial patterns are necessary to be considered in urban design. They are land use, building mass, circulation and open space. All of the spatial pattern elements have different characteristics compared with the other settlements. The results of this study could be used as consideration in determining the design criteria of urban spatial design in the riverside settlement.

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