

The spatial study of unplanned settlements on the coastal of Belawan Medan fishermen village

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Abstract. One of the determining factors that formed informal settlements is the high demand for homes that are not comparable with the homes that were provided by the government. The settlement of Fisherman Village in Belawan Medan was built without a plan by settlers and was not involve government interference so that the spatial pattern formed uncontrollable. The shape of space that stretches represents the distribution of unplanned space. The purpose of this study is to find the structure of settlement and the relationship between the space structures with the spatial pattern in Belawan Medan Fishermen Village. In the process of collecting data, the researcher makes the maps of the observation area, the structure of the space, and the relationship between one space function with the other space functions. Also, the researchers identify the spacing pattern and the effect of one spatial element against the other. This study found a similar spatial pattern between one unplanned settlement and another unplanned settlement and there are also some tendencies of Belawan Medan Fishermen Village settlers when building the built environment in the relationship between building masses and the road network.

Keywords: spatial, structure, settlement, informal

1. Introduction

Unplanned settlements are formed without government plan and indirectly involve settler in the process of building the space. Space grew accordance to the living needs of settlers who ultimately form the function of the space. The spatial functions associated with spatial forms affect the spatial pattern of settlements [1, 5, 6, 11]. Spatial extensively can be defined as space. In the built environment, spatially refers to physical elements such as structural systems, utility systems, road networks, and open spaces [9]. Spatial or spatial planning is a major part of regional and urban planning that includes land use layouts, road systems, open spaces, and others [3]. In addition to being identified as part of the spatial structure system, spatial patterns can also be used to detect land use and land cover [4, 7].

The problems of unplanned settlements and the difficulty of identifying the spatial patterns in unplanned settlement cause the settlers often get a one-party policy by the government. Therefore, identifying spatial patterns has advantages such as: (i) make it easier to determine the land-use policies and utility changes and transport systems; (ii) identifying key points for future development; (iii) to implement the effective plan for regional development through integrated support systems [11].



Belawan Medan Fisherman Village consists of formal settlements and unplanned settlements. Unplanned settlements are defined by the lack of a secure housing system, lack of adequate mobility, access to clean water or inadequate sanitation, and the absence of secure tenure status [10]. Also, unplanned settlements also formed as a result of the urbanization process of local communities to the city; the community moved from the densely populated urban areas, and the naturally increasing of the population [2]. The quality of space that formed in unplanned settlements tends to not maximizing the needs of its inhabitants.

The settlements spatial state can be caused by several factors. One contributing factor is the settlement's geographical factor [12]. The pattern of settlements in the coastal areas and settlements on the periphery of the slope can be different in shape. The geographic aspect of the area may influence the dispersion of settlers on determining the area of their settlements. Besides the settlement location factors, the spatial pattern can also affect by the needs of the settler in building the built environment. Although the structural space is not measurable, unplanned settlements are the part of the urban that developed deviate from the patterns and from the regulations that set by the government and city planners [8]. The unplanned settlement of the Belawan Medan Fishermen Village area is a medium of interaction among settlers. These settlements are formed based on the restrictions held by the settlers. These limitations can be seen in the form of economic constraints such as the settlers ability to buy the settler or social restrictions such as kinship and livelihood of the settlers. The irregularities of spatial patterns of unplanned settlements and the different needs of each settle formed diverse patterns from one settlement location to another.

2. Method

This research was conducted by observing and identifying the building-mass, road network, and open space in Belawan Medan Fishermen Village. After conducting the survey and getting observation data, the results of the research will be reviewed with the theories that have been interpreted. The spatial pattern of settlements will be identified by the number of building masses that are formed. After that, the pattern will be inserted into a graph and identified the similarities and differences on one unplanned settlement pattern graph with the other unplanned settlement pattern graphs. After comparing the mass dispersion graph of the building, the researcher will identify the cause of the mass pattern distribution.

3. Results and Discussion

Belawan Medan Fishermen Village is located in the coastal area of Medan Belawan District, Medan City. Medan Belawan district has six sub-districts, and the location of Kampung Nelayan is located in Belawan Bahagia sub-districts. The research area is located on the seafront from Jalan Gulama to the end of Jalan T. M. Pahlawan. This area is directly adjacent to the sea. The northern area is adjacent to Jalan T. M. Pahlawan, the east area bordering by Jalan Tongkol, Jalan Tenggiri, and Jalan Temenung. South area is bordered by Dondong Street, Jalan Sepat, Jalan Selar, and others, while the western area is directly adjacent to the sea. The Fishermen Village of Belawan Medan is one of the built environments built by humans and located in coastal areas. The built environment is characterized by the dominance of man-made structures that are formed by the community's need to survive on the environment they chooses their shelter. The built environment consists of physical and non-physical elements. Physical elements in Belawan Medan Fisherman Village settlements are mass buildings, road networks, and open spaces (Figure 1).

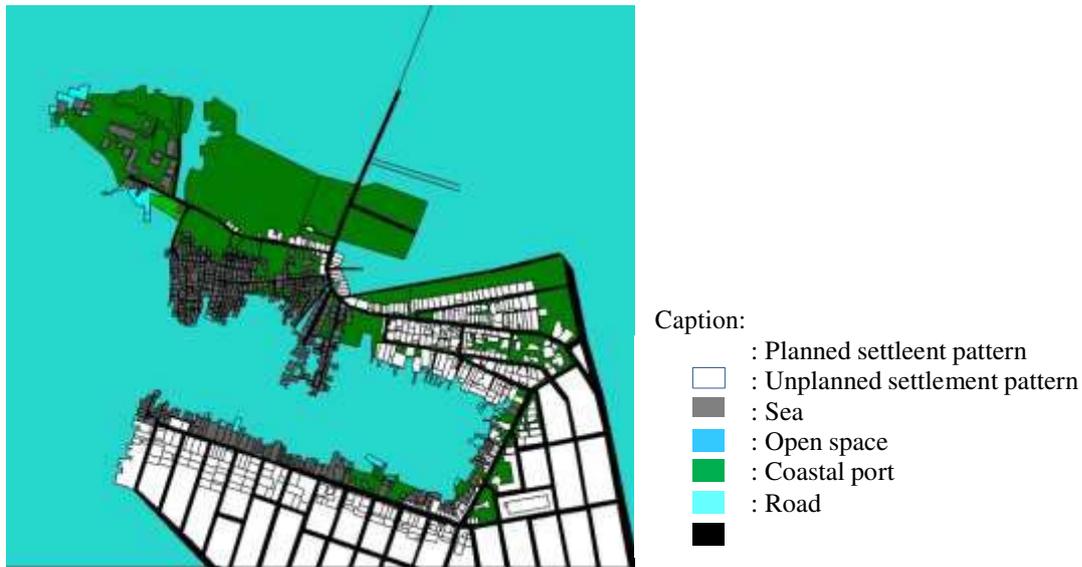
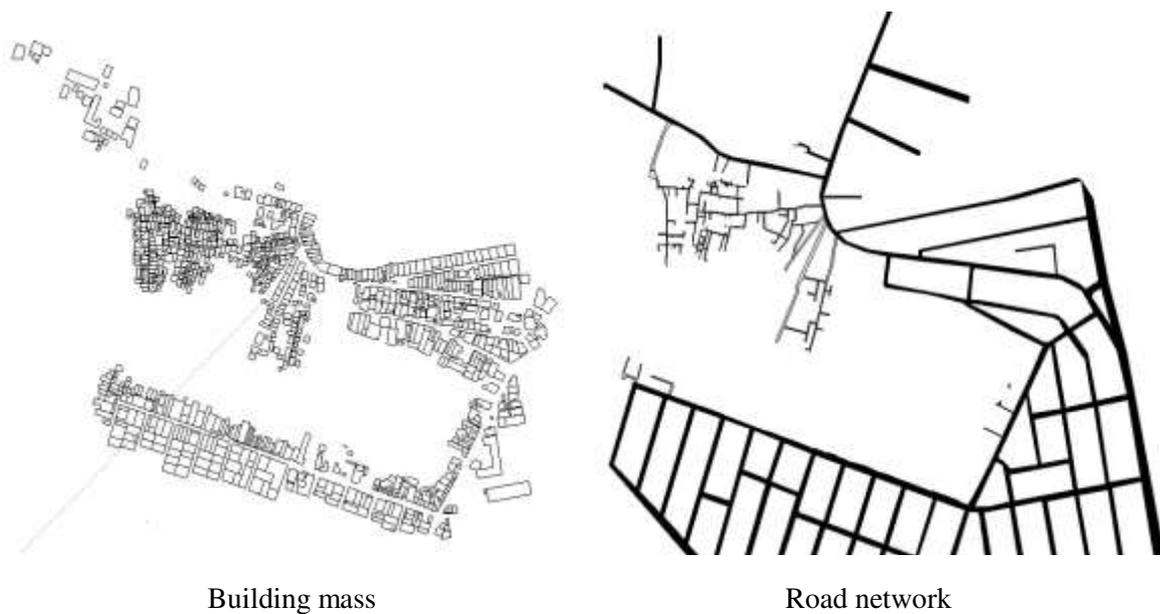
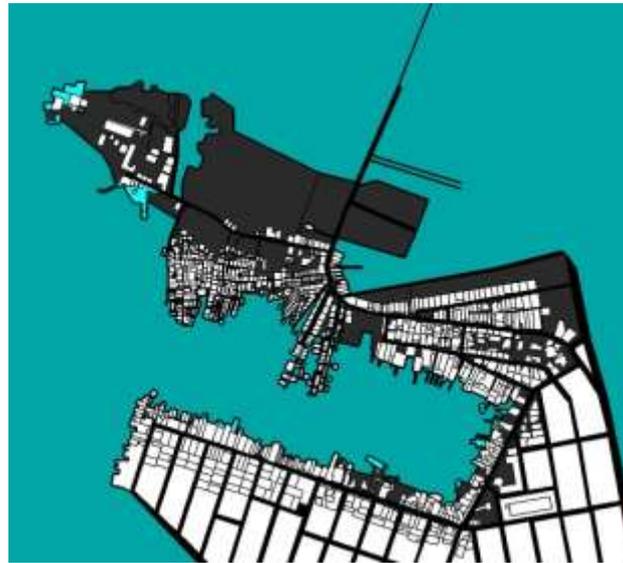


Figure 1. Research Location

The spatial pattern of settlement is usually followed by the layout of space usage, road system, and open space (Figure 2) [9]. These forms become a spatial pattern because they are formed based on basic human desire to survive. The quality of space formed in unplanned settlements tends not to be maximized the needs of its inhabitants. This is due to the limitations of settlers in building the built environment. Such limitations include economic limitations, social pressures, and limited land area. This proves that the cause of unplanned settlements is the inadequate spatial planning, non-updating and complex regulatory systems, housing policies that are unable to ensure the provision of housing for saleable prices to society, and an outdated public administration structure [10]. Formation of the unplanned settlements also resulted from urbanization of people from urban areas, people who moved from overcrowded urban areas, and natural population growth [2].





Open space

Figure 2. Building mass block, road network, and open space layout

The diversity of the settlements location in Belawan Medan Fishermen Village can cause a different form of pattern. The state of an area and the specific geographic factors of a settlement may affect settlement patterns [12]. Unplanned settlement locations in Belawan Medan Fishermen Village spread into several points of location where the majority built directly above the sea. Many of the settlers choose to stay in lower places land because it was more profitable [12].

Based on unplanned residential characteristics of UN-Habitat in 2003, unplanned areas in Belawan Medan Fishermen Village are located in the sea-oriented area of Gulama Street, Hiu Street area, Bakti Aisle, Amal Aisle, Sukur Aisle, Supir Aisle, and the end of T. M. Pahlawan Street. Unplanned settlements position on Belawan Medan Fishermen Village majority located in the coastal area. The unplanned settlement position spread along the coastal road with the orientation of the building facing the formal road or oriented towards the sea. Outside of the informal settlement, there is a formal residential area. Around the 1960s, this settlement area was a muddy slush and was not occupied by any settler. However, as a result of the government's resettlement process in the 1960s, the land in this area was elevated and compacted to be constructed. This settlement process continues until the settlement area spreads close to the coastal or seafront areas even though the coastal area is governmentally mandatory. Now, in the residential area of Fishermen Village, there are two types of settlement areas, namely formal settlements and unplanned settlements. In unplanned settlement areas, buildings are not built on private land, buildings were built without government approval, there is no access to clean water, and no sewerage. The areas of settlements that built without government regulation have a building mass pattern that tends to look random. The coastal periphery area is one of the areas with lower soil compared to the surrounding area. The location of land on the coastal areas tends to make it easier for settlers to construct buildings because there are no clear rules regarding building permits. In principle, the coastal area within a distance of 20-50 meters should be free from physical development in any kind. In fact, it is the part of the area that becomes the option for some immigrants who have not had a place to live and wants to make a living better than the previous conditions.



Figure 3. The location of the unplanned settlement that divided into several points: (a) Gulama Street, (b) Hiu Street, (c) Bakti Aisle, (d) Amal Aisle, (e) Sukur Aisle, (f) Supir Aisle, (g) The edge of T. M. Pahlawan Street

On the mass building pattern, the mass distribution of buildings in unplanned settlements appears irregular but has its fragments [8]. Fragmented in this regard is that unplanned settlement patterns consist of parts of mass building groups. The thing that encourages the pattern is the social condition that formed when the people occupy the land in this village. The space formed by this social factor forces the form of the spatial pattern. In addition to social conditions, settlers also have restrictions in building the built environment. If the formal settlement's boundary is a regulation of the government, in unplanned settlements the limits are the location of settlements, soil conditions, land area, economic condition, and social status of the community. All the needs of the settler in building the built environment are limited due to the factors mentioned earlier.

In analyzing spatial patterns of unplanned settlements, spatial patterns can be divided into sections of mass building groups [8]. In dividing the settlement groups in Fishermen Village, the mass buildings were divided into several roads and aisles (Figure 3). In each street and aisle, there are masses, road networks, and open spaces that are then identified into several pattern types (Figure 4).



(a)

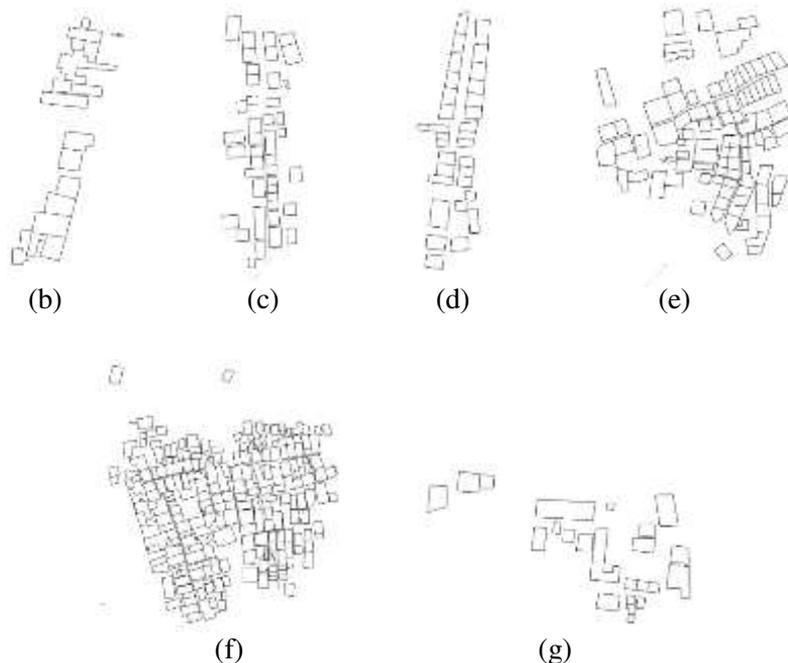


Figure 4. The types of built spatial patterns of informal settlements in the Fishermen Village of Belawan Medan area: (a) Gulama Street, (b) Hiu Street, (c) Bakti Aisle, (d) Amal Aisle, (e) Sukur Aisle, (f) Supir Aisle, and (g) The edge of T. M. Pahlawan Street

The section then can be distinguished by the number of masonry blocks of buildings that are interspersed. Through the number of blocks of masses in interconnected buildings, it can be proved that there is a pattern or arrangement of fragments between an unplanned settlement with other unplanned settlement [8]. The process of examination or verification is done by geometric calculations by comparing the types of mass building groups formed and a number of mass groups of the building. The building mass group is identified by the variable s . Thus, a mass group of buildings consisting of a single mass building block is referred to $s = 1$. Then, the mass group of buildings consisting of two mass blocks of buildings is called $s = 2$, and so on. Once identified, it is calculated by how much the number of each mass group of buildings is and put into a graph. The building mass group is called island [8].

For example, at Bakti Aisle the building mass group is between $s = 1$ to $s = 4$ (Figure 5). Can be seen in some parts of the mass buildings consists of two to four adjacent buildings (Figure 5). Through the identification process on the mass pattern of informal settlement buildings in Bakti Aisle, the islands that stand alone ($s = 1$) amounts to 20 pieces. For $s = 2$ there are 6 islands. For $s = 3$ it has 2 pieces, and $s = 4$ is has 1 piece of island.



Key Map

Figure 5. An example of the identification process between the amounts of mass groups of buildings (island) in the area of Bakti Aisle

Using a geometry calculation like above, any unplanned settlement pattern can be identified whether it has a spatial pattern equation or not [8]. Previous research was conducted on unplanned settlements in Brazil and Nairobi, Kenya [8]. The distribution chart of mass building groups in Kenya is shown in Figure 6.

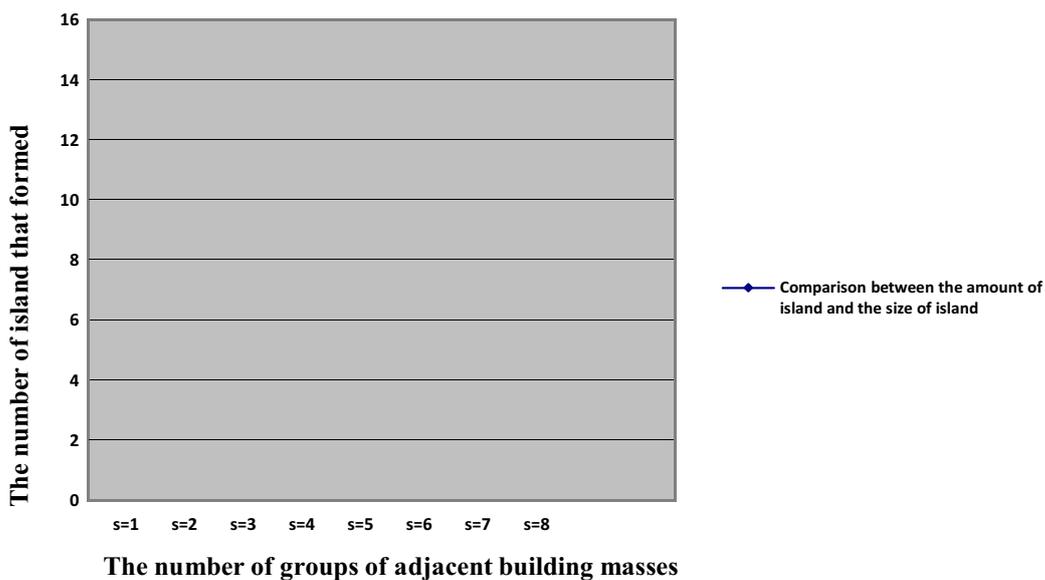


Figure 6. Comparison of the number of islands that formed in unplanned settlements in Nairobi, Kenya
Source: Sobreira and Gomes, 2001

Through 7 unplanned settlement locations in Medan Belawan Fishermen Village, the distribution of mass groups of buildings (island) looks diverse. The number of s (islands) showing the adjacent group of building blocks combined from all unplanned settlement locations in the region is calculated in Table 1.

Table 1. The calculation of the mass groups of buildings (island) in unplanned settlements Belawan Medan Fishermen Village

S	Location										Total
	(a) Gulama Street	(b) Hiu Street	(c) Bakti Aisle	(d) Amal Aisle	(e) Sukur Aisle	(f) Supir Aisle	(g) The edge of T. M. Street				
s=1	8	2	20	7	17	39	16	109			
s=2	2	1	6	-	8	8	2	27			
s=3	1	-	2	3	3	2	1	12			
s=4	1	-	1	1	1	2	-	6			
s=5	1	-	-	-	1	2	-	4			
s=6	-	1	-	2	2	1	-	6			
s=7	1	1	-	-	-	2	-	4			
s=8	-	-	-	-	-	2	-	2			
s=9	3	-	-	-	1	-	-	4			
s=11	-	-	-	-	-	1	-	1			
s=12	-	-	-	-	1	-	-	1			
s=13	-	-	-	-	1	-	-	1			
s=14	-	-	-	-	-	1	-	1			
s=16	1	-	-	-	-	-	-	1			
s=17	-	-	-	-	-	1	-	1			
s=18	-	-	-	-	-	1	-	1			
s=21	1	-	-	-	-	1	-	2			
s=31	-	-	-	-	-	1	-	1			

After the calculations of the mass distribution of buildings in Table 1, the number of s (islands) that formed then compared with the existing variable s in each unplanned settlement location. The results are inserted into a graph. Graph of mass distribution of buildings in Belawan Medan Fishermen Village can be seen in Figure 7.

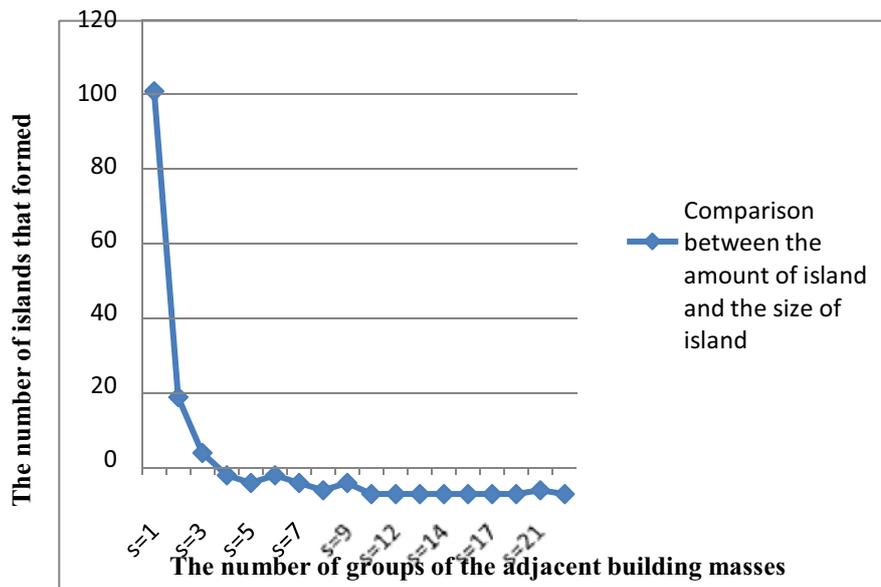


Figure 7. Comparison of the number of islands with the width of the island in unplanned settlements Belawan Medan Fishermen Village

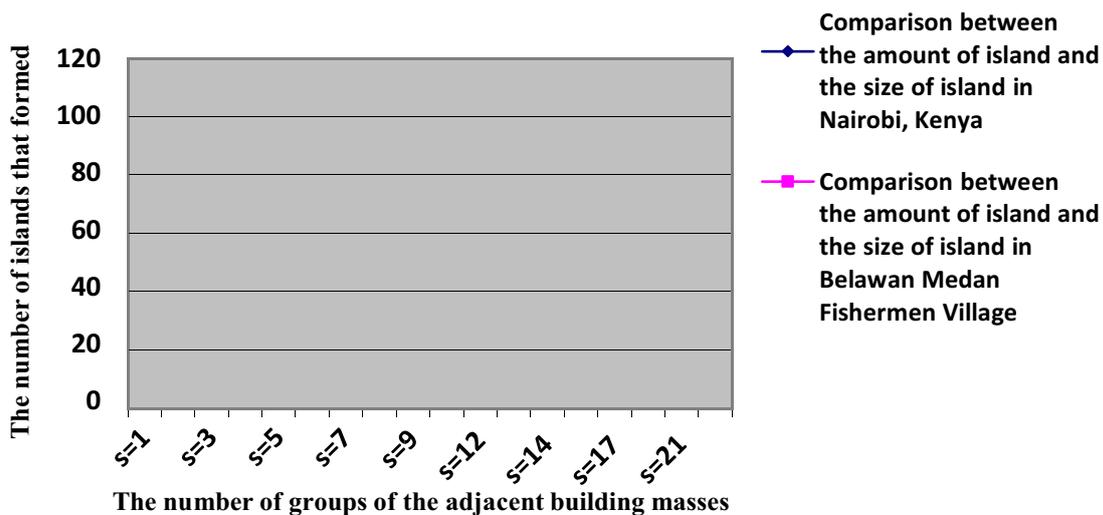


Figure 8. Combined charts as comparison of unplanned settlements in Nairobi, Kenya with Belawan Medan Fishermen Village

Afterward, the graph of the mass distribution of buildings between Belawan Medan Fishermen Village and the unplanned settlements in Nairobi, Kenya was compared and combined into a similar graph (Graph 3). Based on the analysis of unplanned settlements in Nairobi, Kenya, there are many mass building groups that stand alone ($s = 1$) [8]. This is also found in the unplanned settlements of Belawan Medan Fishermen Village where the settlement consists more of the isolated building than the group of masonry buildings. In the settlement graph in Nairobi, after the point $s = 1$, the graph continues to decline until it rises again at the point $s = 5$. While in the area of Belawan Medan Fishermen Village, after point $s = 1$, the chart continues to decline into the ascend at point $s = 6$. Then at the settlement in Nairobi, the point on the graph increases again at $s = 8$. In Belawan Medan Fishermen Village, the point increases again at point $s = 9$.

The graph of mass dispersal between the Belawan Medan Fishermen Villages and the informal settlements in Nairobi, Kenya has a similar pattern of increase and decline. There is a slight difference in pattern increase at the point $s = 8$ and $s = 9$ where this can be due to the difference in the number of building masses in the Nairobi, Kenya and Belawan Medan Fishermen Villages. In unplanned settlements in Nairobi, the number of building mass groups ($s =$ island) reached $s = 8$. Much less than in the settlement of Kampung Nelayan with $s = 21$, which consist of 21 building mass group ($s =$ island). Based on the results of the graph it can be concluded that the spatial pattern of planned settlements found in both settlements have the same pattern although the form of settlement is not necessarily the same.

Based on the results of the graph (Figure 8), Belawan Medan Fishermen Village settlers tend to build a stand-alone building. This may be due to the settler's need for lighting, aircraft, and road network circulation. The narrow land and the need for circulation cause settlers to prefer to build shelters separate from other dwellings.



Figure 9. Residential conditions that stand apart in the Supir Aisle, Belawan Medan Fishermen Village

Additionally, unsuitable unplanned settlement road network conditions can cause settlers to form their road network. The narrowness of land can also cause settlers to form their space or land according to their needs (Figure 10).

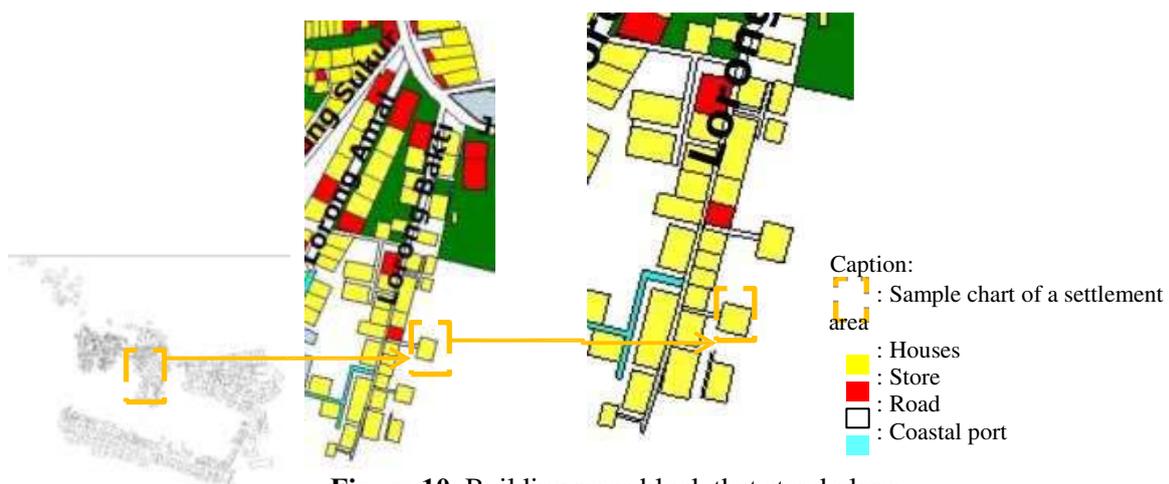


Figure 10. Building mass block that stand-alone

As a result of the community's need for shelter and the imbalance of the land area in the settlement, the community then built their roads and land positions. This led to the existence of several self-contained shelters with a separate road network (Figure 10). The condition of the limitations and the

behavior of building this road network can be one of the causes of many single-standing buildings in the Fishermen Village Belawan Medan.



Caption:

- - - : Road network
- - - : Mass block location

Figure 11. The conditions of mass distribution that following the road network

Another tendency on residential development in Belawan Medan Fishermen Village is the arrangement of mass building patterns that formed accordance the state of the road network. The shape of the building follows the path of the road network in front of it (Figure 11). This can be seen in the area of Sukur Aisle and Bakti Aisle. The winding and branched road at Sukur Aisle tends to cause the building to follow the curving road lane. The road area of Bakti Aisle tends to be straight and ends at sea. The mass buildings on Bakti Aisle tended to formed rectangular and arranged linearly because the road network is also shaped straight. Buildings tend to follow the pattern of the roads that have been built. If the road is built linear, then the patterns of the buildings that are formed also tend to be straight with the rectangular plane. If the road is built branched and curved, the pattern of the building also tends to curves and following the road while it looks asymmetrical. This tendency is caused by the condition of the road network that can affect the form of building mass in which the pattern of building masses that are formed tend to follow or followed by the layout of space functions, road networks, and open space [3].

In the spatial pattern of settlement of Belawan Fisherman Village, it can also be identified that the approaching formal road built by the government, the building masses that formed tend to be adjacent than in the coastal area. On the area approaching the formal road (T. M. Pahlawan Street) on Amal Aisle, there are 5 and 6 buildings attached and form a group mass of buildings (island). However, the more it goes toward the sea, the building masses that formed are more often stand-alone ($s = 1$).

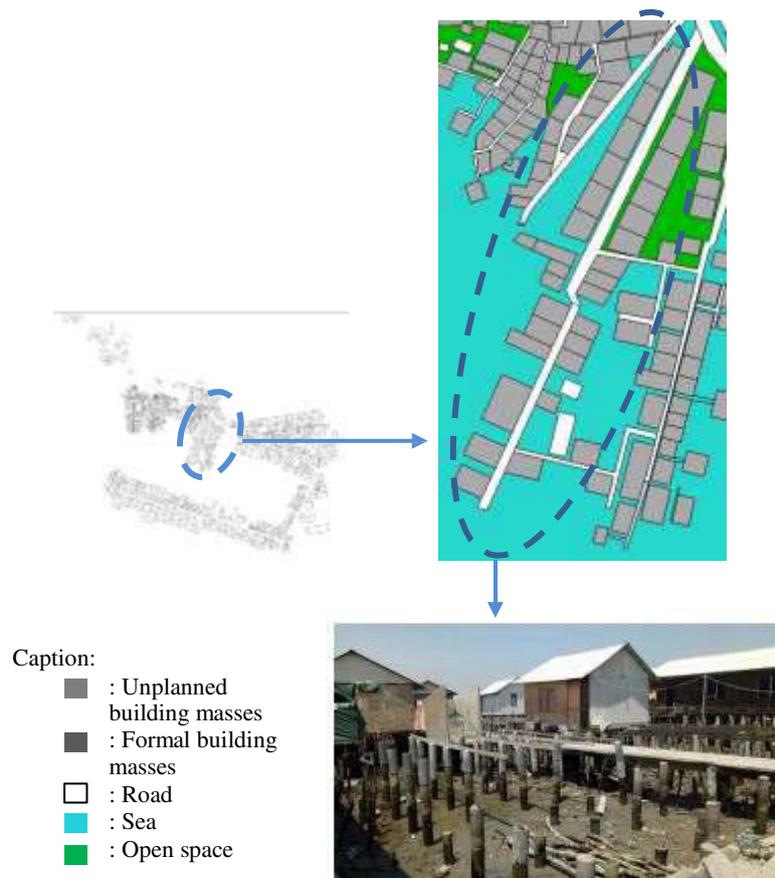


Figure 12. The condition of the building and the road network at Amal Aisle, Belawan Medan Fishermen Village

The differences of the number of adjacent building masses or island assemblages can be caused by the differences of the location or geographic position in which the building is located [3]. Buildings built closer to the sea tend to form a mass of stand-alone buildings. Can be identified in unplanned settlement areas on Gulama Street that reach $s = 21$ while in this area the unplanned buildings are directly oriented towards formal roads. Compared with the Supir Aisle most of the buildings stand close to the coastline where $s = 1$ reaches 39 buildings. This can be caused by unplanned settlement conditions when the building is built. Settlers in unplanned settlements tend to build their buildings. Building their homes by sharing walls with other settlers can lead to some changes in structural systems that have been established previously. Settlers who build their buildings do not necessarily know the structural system of the building, so it is more secure if the building is built alone rather than built adjacent. In contrast to the areas that closer to primer street where structural systems or foundations of the buildings, like the strength of the foundation and structure, are more common to know than the foundations of the building area that build above the sea.

4. Conclusions

Spatial patterns of unplanned settlements can seem random and unidentified, but there is a pattern that linking the formation of an unplanned settlement with another unplanned settlements [8]. The informal settlement in Belawan Medan Fishermen Village has many building masses that stand alone compared to the mass that built adjacent. The tendency of building masses to stand alone can be caused by the need for circulation and lighting in buildings. Limited land conditions and the adjacent building masses will increase the density of residential sites and affect the condition of circulation and lighting. Based on these limitations and needs, the settlers chose to build a stand-alone building. The difference in the

number of mass groups may be caused by the location of the settlement land. Settlements that tend to be closer to land or formal roads built by the government build more adjacent buildings than the building that closer to the sea. The patterns of the building masses that formed also follow the direction of the built road network. If the road network branched off, then the building followed the branching of the road, and so also if the road network is formed linearly then the building stood straight along the linear road. This indicates the effect of the road network and the building pattern.

Acknowledgements

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References

- [1] Darjosanjoto E T 2005 Spatial growth and function in a Javanese coastal city *The 5th International Space Syntax Symposium Proceeding (ISSN 90-8594-002-8), TUDelft* pp 13-17
- [2] Doan P and Oduro C Y 2012 Patterns of population growth in peri-urban Accra, Ghana *International Journal of Urban and Regional Research* **36** (6) pp 1306-1325
- [3] Hao J, Zhu J and Zhong R 2015 The rise of big data on urban studies and planning practices in China: Review and open research issues *Journal of Urban Management* **4** (2) pp 92-124
- [4] Hepcan S, Hepcan C C, Kilicaslan C, Ozkan M B and Kocan N 2012 Analyzing landscape change and urban sprawl in a Mediterranean coastal landscape: a case study from Izmir Turkey *Journal of Coastal Research* **29** (2) pp 301-310
- [5] Hurskainen P and Pellikka P 2004 Change detection of informal settlements using multi-temporal aerial photographs—the case of Voi, SE-Kenya *Proceedings of the 5th African Association of Remote Sensing of the Environment conference, Nairobi, Kenya, unpaginated CD-ROM*
- [6] Muriuki G, Seabrook L, McAlpine C, Jacobson C, Price B and Baxter G 2011 Land cover change under unplanned human settlements: A study of the Chyulu Hills squatters, Kenya *Landscape and Urban Planning* **99** (2) pp 154-165
- [7] Nguyen H H, McAlpine C, Pullar D, Johansen K and Duke N C 2013 The relationship of spatial-temporal changes in fringe mangrove extent and adjacent land-use: Case study of Kien Giang coast, Vietnam *Ocean & coastal management* **76** pp 12-22
- [8] Sobreira F and Gomes M 2001 The Geometry of Slums: boundaries, packing and diversity
- [9] Trujillo T A 2012 *Spatial and process strategies toward the formalization and integration of the informal settlement, Villa 31, in Buenos Aires, Argentina* (USA: Doctoral dissertation, University of Washington)
- [10] Tsenkova S 2010 Informal settlements in post-communist cities: Diversity factors and patterns. *Urbani izziv* **21** (2) pp 73-84
- [11] Vaz E 2014 Managing urban coastal areas through landscape metrics: An assessment of Mumbai's mangrove system *Ocean & Coastal Management* **98** pp 27-37
- [12] Zhang Z, Xiao R, Shortridge A and Wu J 2014 Spatial point pattern analysis of human settlements and geographical associations in eastern coastal China—A case study *International journal of environmental research and public health* **11** (3) pp 2818-2833