ISSN No:-2456-2165

An Assessment of Physical Sustainability in Kampong Polehan

Resmi Amalia
Department of Urban and Regional Planning
Engineering Faculty, Brawijaya University
Malang, Indonesia

Surjono
Department of Urban and Regional Planning
Engineering Faculty, Brawijaya University
Malang, Indonesia

Abdul Wahid Hasyim
Department of Urban and Regional Planning
Engineering Faculty, Brawijaya University
Malang, Indonesia

Abstract:- Urban kampong is one of the typical forms of urban settlement in Indonesia, and currently constitutes the majority of urban settlements in many cities in Indonesia. The high proportion of land use for urbansettlements in Indonesia highlights the importance and contribution of urban kampong for the overall sustainability of the city. The high density of buildings in the urban kampung forms a compact residential environment which is recently claimed as a sustainable form of built-environment. Malang City is one of the medium-sized cities in Indonesia that intensifies the development of thematic kampongs to improve the quality of urban kampongs within the city. One of the interesting kampongs in Malang City is Polehan Kampong. Polehan Kampong is one of 45 thematic kampongs in Malang and a grantee of the Community-based Urban Upgrading Program that is considered to have a sufficient level of readiness. Therefore, it is crucial to see whether the development being carried out leads to sustainability, and the first essential step is to assess the physical aspect ofthe Kampong. Rapfishmultidimensional scaling (MDS) was used to estimate the physical sustainability status in Polehan Kampong. The result shows that compactness is the only variable that at an acceptable level, but the others are below expectation.

Keywords:- *Kampong; Settlement; Sustainability.*

I. INTRODUCTION

As centers of population concentration, urban services, as well as economic growth, cities have their attractiveness for the peopleso that urbanization is inevitable. The Population Division of the United Nations Department of Social and Economic Affairs reports that 66% of the population is estimated to live in urban areas by 2050 [1].This trend shows that the number of urban population is increasing and denser. In line with the increasingly dense population and urban activities, the application of the concept of sustainability is an urgent need to improve the quality of urban life today and in the future.

A sustainable city tends to minimize energy use, recycle waste, pollution (air, water, land), create a compact city design, mass transportation, and mixed land use[2]. The achievement of sustainability city is influenced by the components of the city itself, one of which is settlements. Settlements are a centralpart of the city. Most of the population's activities begin and end in settlements. Some residents are more active in the settlement itself than outsides. Therefore, the achievement of sustainability in these settlements also affects the realization of the sustainability of a city.

Settlements can be formed through a planning process or without a planning process [3]. An urban kampongis a form of settlement that develops without any planning process and residential units in the city that are considered as traditional settlement arrangements before the inclusion of modern settlement planning [4].

We can find urban kampongsin every city in Indonesia. The 2013-2018 Medium-term Development Plan (RPJM) of Malang Citystates that land use for urban kampong dominates the land use in the municipality, which is approximately 36% of the total area. This condition shows that urban kampongsare the main settlement for living in Malang City. On the other hand, the high proportion of land use for kampong settlements also shows that urban kampungs are the main factor in constituting the sustainability of Malang City.

Along with the development of Malang City, it is also a challenge for urban kampong to survive and meet the needs of their residents for a proper and sustainable residential environment. However, in several urban kampong there are still several problems, including those in PolehanSub-district (*kelurahan*). PolehanSub-district has two forms of settlement, namely urban kampong and planned-housing estate. The Mayor of Malang Decree Number 188.45/35.75.112/2015lists that PolehanKampong is one slum areas in the municipality under following eight criteria:building conditions, building density, accessibility, drainage infrastructure, water, sanitation, solid waste, and fire protection. The area of slum settlements in PolehanSub-

district is the largest in Blimbing District, covers about 17.5 ha out of 25.04 ha (70%).The identified slum area in PolehanSub-District is in the kampong area.This identification shows that Polehan Kampong must improve the eight criteria of its physical aspects if the City's goal is to achieve sustainability.

Several weaknesses of physical aspects in Polehan Kampong are: lack of water absorption and green open space (less than 30% of land area); distance between buildings is too close (ranges from 0 - 0.5 meters); building density reaching 65 buildings/ha); narrow alley's width (1-1.5 meters) limit mobility and accessibility. Due to the road condition, settlement can only be accessed by walkor two-wheeled vehicles, so that community activities are limited. Apart from that, the infrastructure services are also limited.

In terms of building mass (building density and distance between buildings) and road network, the kampong settlements tend to form a compact environment which corresponds to the concept of a sustainable urban form [5]. In Jabareen's research, 2006, where the compactness of the built environment is more supportive of sustainability.Therefore, whether the urban form in Polehan Kampong has supported sustainability is identified in this study. Our concept of sustainable urban form is based on Jabareen's concept of the sustainable form [6].

II. METHOD

There are 2 (two) main steps analysis used in this research. There was a qualitative descriptive analysis that used to measure physical characters of urban kampong and planned housing in PolehanSub-district and Rapfish MDS that used to identify the status of physical sustainability.

Our theorization of physical characters of urban kampong and planned housing was based on the sustainable urban form conceptual of Jabareen [6].The 8 (eight) variables used to assess the physical characteristics of this research are compactness, passive solar design, green open space, connectivity, building volume, density, diversity, and mixed land use.

A. Compactness

Compactness index describes the level of compactness of an area. Compactness, are closely related to the equitable distribution of resources and easily accessible [7].If the compactness index value is close to the value of 1 (one), the area is defined as more compact. The compactness index is calculated using the following equation:

$$C = \frac{D_i}{D_i'} \quad (1)$$

$$D_i = 2\sqrt{\frac{A_i}{\pi}} \quad (2)$$

Where:
C = compactness index
D_i = diameter of a circle with the same area of area i
D_i' = the longest distance between two points of area i
A_i = the area of i

B. Passive Solar Design

The daytime natural lighting factor can be determined by the following equation (SNI 03-2396-2001):

$$fl_{\min(n)} = \frac{Ei_{(n)}}{Eo_{(n)}}\ x\ 100\% \quad (3)$$

Where:
$Fl_{min(n)}$ = Daytime natural lighting factor (%)
$E_{i(n)}$ = Indoor measurement (lux)
$E_{o(n)}$ = Outdoor measurement (lux)

C. Green Open Space

Greening and vegetation cover can alleviate the adverse effects of increased urban area and density, where larger green spaces have a positive impact on urban sustainability[8].Green open space is the percentage of green open space in each residential area.

D. Connectivity

The connectivity index is a composite index of Linkage-Node Ratio (LNR), Connected Node Ratio (CNR), Intersection Density (ID), Length of Road Density (LRD), and Land Allocated to Streets (LAS).

E. Building Volume

The building volume is a measure of building densification. It measuresFloor Area Ratio (FAR) and Building Covered Ratio (BCR).

F. Density

Residential Density Index was the ratio between the total amount of building and the area of the neighbourhood.

G. Diversity

Housing Diversity Index is used to determine the diversityof housing types.The following equation can determine the Housing Diversity Index:

$$Housing\ Diversity\ Index = \frac{\sum_{i=1}^{k} n_i(n_i-1)}{n(n-1)} \quad (4)$$

Where:
n_i = the number of houses in each category
n = the total number of houses in all categories
k = number of categories

H. Land Use Mixed

Placing activities and destinations in close proximity to settlements will reduce travel distances [9]. Entropy Index is used to determine the diversity of land uses. The following equation can determine entropy Index:

$$EI = -K\sum_{i=1}^{N}\frac{pi}{pt}.\log(\frac{pi}{pt}) \quad (5)$$

Where:
EI = Entropy Index
K = positive weighting constant, K is 1 if no weighting
p_i = the area of land use-i

p_t = total land-use area

Rapfish analysis was used to determine the status of physical sustainability in Polehan. The Rapfish method is based on the ordination technique with Multidimensional Scaling (MDS), which tries to carry out multidimensional transformations into lower dimensions. Each dimension has attributes or indicators related to sustainability[10].

The position of the settlement's sustainability status under this study is projected on a horizontal line on a different ordination scale between the two extreme points, namely the "bad" and the "good" points which are given an index value between 0 and 100% [11].

III. RESULT AND DISCUSSION

A. Physical Characteristics

a. Compactness

Neighbourhoods in PolehanSub-District have a compactness value range between 0.57 - 0.88. The index value was categorized based on the standardindexing classification of 4 classes, where the values 0 - 0.25 are categorized as areas that are not compact, then the values 0.26 - 0.50 are less compact areas. Values of 0.51 - 0.75 are categorized as compact areas, and values of 0.76 - 1.00 are categorized as very compact areas.

TABLE I. COMPACTNESS INDEX IN POLEHAN SUB-DISTRICT

No	Neighbourhood	C
	Urban Kampong	
1	Neighbourhood 1	0.83
2	Neighbourhood 2	0.87
3	Neighbourhood 3	0.84
4	Neighbourhood 4	0.57
5	Neighbourhood 6	0.68
	Planned Housing	
6	Neighbourhood 5	0.88
7	Neighbourhood 7	0.66
8	Neighbourhood 8	0.59
9	Neighbourhood 9	0.84

Based on the results of these calculations, it can be seen that the neighbourhoods in urban kampong settlements tend to be more compact than those in organized housing. If it is linked to the distribution of resources and services, in a more compact neighbourhood, the resources can be distributed more evenly. Services and infrastructure are more comfortable to reach by all people in that area. In the neighbourhood 1, 2, 3, 5, services are more comfortable to reach by the whole community in the area compared to other neighbourhood (very compact category). However, in the existing conditions for neighbourhoods 1,2, 3, which are urban kampong settlements, some of the services can only be accessed by pedestrians or two-wheeled vehicles. In other words, the compactness of the area in the urban kampong settlement neighbourhood has limitations in terms of accessibility, especially related to the types of vehicles that can be used.

b. Passive Solar Design

Passive Solar Design aims to maximize the use of natural light (sun) for daily needs. In the context of housing,Apart fromconserving electricity usage,passivesolar designal so affects the health of the occupants.

The natural lighting conditions in organized housing are higher than in the urban kampong,which is in line with the existing conditions. Natural lighting is determined by the number of apertures (in the form of windows, doors and vents) in the dwelling. In organized housing, it is possible to make more apertures, and this is because the distance between buildings (both sides and back) and building boundaries tend to be wider compare to urban kampong settlements.

TABLE II. NATURAL LIGHTING COMPOSITE INDEXIN POLEHAN SUB-DISTRICT

No	Neighbourhood	Natural Lighting Composite Index Average
	Urban Kampong	
1	Neighbourhood 1	14,70
2	Neighbourhood 2	15,97
3	Neighbourhood 3	12,46
4	Neighbourhood 4	13,41
5	Neighbourhood 6	13,33
	Planned Housing	
6	Neighbourhood 5	26,43
7	Neighbourhood 7	13,39
8	Neighbourhood 8	18,44
9	Neighbourhood 9	21,25

Also, the neighbourhood street, which ranges from 1 - 1.5 meters in neighbourhoods to urban kampongsettlements, also affects the sun exposure that can be captured by the side of the building.Itis undoubtedly different from neighbourhood streets in organized housing, which range from 3-5 meters, which allows more sun exposure in the morning, afternoon, and evening angles.

c. Green Open Space

Green open space has considerable benefits for cities.Green open space is not only physically beneficial for the environment but also for social purposes.

In the existing conditions, public green open spaces are parks and sports fields. The rest of it is a private green open space in the yard of the house.

Based on these results, it can be seen that the existence of green open space for public spaces in Polehan Kampong is not evenly existing, in several neighbourhoods it already existsyet still less than 30% of the width of the area. This condition shows that the public space,mostly public green open space at the neighbourhood level in Polehan Sub-district, is still minimum.

The lack of open space can also be seen in the use of the neighbourhood street as open space, especially in urban

kampong settlements where the buildings are dense, and there are almost no green open spaces in each building lot.

TABLE III. GREEN OPEN SPACEINDEXIN POLEHAN SUB-DISTRICT

No	Neighbourhood	Percentage RTH (%)	index RTH
	Urban Kampong		
1	Neighbourhood 1	0.000	0.000
2	Neighbourhood 2	0.000	0.000
3	Neighbourhood 3	0.371	0.012
4	Neighbourhood 4	0.000	0.000
5	Neighbourhood 6	0.545	0.018
	Planned Housing		
6	Neighbourhood 5	0.482	0.016
7	Neighbourhood 7	0.000	0.000
8	Neighbourhood 8	0.000	0.000
9	Neighbourhood 9	0.351	0.012

d. Connectivity

TABLE IV. CONNECTIVITY COMPOSITE INDEX IN POLEHAN SUB-DISTRICT

No	Neighbourhood	Composite Index
	Urban Kampong	
1	Neighbourhood 1	47.5
2	Neighbourhood 2	48.5
3	Neighbourhood 3	57.5
4	Neighbourhood 4	64.0
5	Neighbourhood 6	50.7
	Planned Housing	
6	Neighbourhood 5	66.6
7	Neighbourhood 7	86.9
8	Neighbourhood 8	88.3
9	Neighbourhood 9	81.6

The road network connectivity in this study area is measured by using Link-Node Ratio (LNR), Connected Node Ratio (CNR), intersection density, Length of Road Density (LRD), and Land Allocated to Streets (LAS). Each of these indicators will be compiled to assess road network connectivity in each neighbourhood, both in urban kampong settlements and in organized housing.

Overall connectivity in organized housing is better than in urban kampong. This condition also describes the movement pattern and the type of vehicles used. In organized housing, the pattern of movement spreads outeach Neighbourhood road network, the use of vehicles is also more diversity, since the road is more extensive that makes people more comfortable to move (people and goods) to the house. This condition also supports trade and small/medium industrial activities that are carried out in homes.

e. Building Volume

The conditions for the volume of buildings in PolehanSub-Districtare as follows in TABLE V.This condition illustrates that most of the buildings in Polehansub-district both in the urban kampongand in plannedhousing are 1-storey buildings, with the average BCR in the urban kampong ranging from 83.1% - 92.2% and the average BCR in planned housing ranges from 74.3% - 88.0%.Based on the table above, it also shows that the percentage of built land in the kampongs is higher with a higher density compared to the volume of buildings in planned housing.

TABLE V. THE AVERAGE OF BUILDING VOLUME IN POLEHAN SUB-DISTRICT

No	Neighbourhood	BCR Average	FAR Average	Building Volume Average (m3)
Urban Kampong				
1	Neighbourhood 1	92,2%	1,1	248,3
2	Neighbourhood 2	88,8%	0,9	214,7
3	Neighbourhood 3	87,9%	1,0	212,9
4	Neighbourhood 4	87,0%	1,0	351,5
5	Neighbourhood 6	83,1%	0,9	250,3
Planned housing				
6	Neighbourhood 5	88,0%	0,9	308,0
7	Neighbourhood 7	74,3%	0,7	180,5
8	Neighbourhood 8	76,7%	0,8	351,6
9	Neighbourhood 9	77,1%	0,8	629,2

TABLE VI. THE BUILDING DENSITY OF POLEHAN SUB-DISTRICT

No	Neighbourhood	Building Density (unit/ha)	Population Density (person/ha)
	Urban Kampong		
1	Neighbourhood 1	63	291
2	Neighbourhood 2	65	239
3	Neighbourhood 3	35	140
4	Neighbourhood 4	63	236
5	Neighbourhood 6	38	154
	Planned Housing		
6	Neighbourhood 5	12	44
7	Neighbourhood 7	25	96
8	Neighbourhood 8	21	71
9	Neighbourhood 9	26	82

However, with the number of building floors dominated by 1 floor, this shows that the volume of buildings in the urban kampong tends to be horizontally higher.

a. Density

The building density in urban kampong settlements and organized housing can be seen in the following TABLE VI.The building density in urban kampong settlements ranges from 35-65 units/ha and in organized housing ranges from 12-26 units/ha. This figure shows that the building density in the urban kampongis 3 (three) times greater than the density of buildings in organized housing. In other words, urban kampong settlements accommodate more dwellings.

b. Diversity

The various conditions of housing types in PolehanSub-Districtare as follows in TABLE VII. Based on the results of the calculations, it shows that both in urban kampong and planned housing has a small diversity of

ISSN No:-2456-2165

dwellings, almost all of which are single houses. So that both the settlement have not supported the fulfilment of houses with various needs. This is supported by conditions in settlement of Polehanurban kampong where there are still many single houses inhabited by more than one family.

TABLE VII. HOUSING DIVERSITY INDEX INPOLEHAN SUB-DISTRICT

No	Neighbourhood	Diversity Index
	Urban Kampong	
1	Neighbourhood 1	0.993
2	Neighbourhood 2	0.997
3	Neighbourhood 3	1.000
4	Neighbourhood 4	1.000
5	Neighbourhood 6	0.994
	Planned Housing	
6	Neighbourhood 5	1.000
7	Neighbourhood 7	1.000
8	Neighbourhood 8	1.000
9	Neighbourhood 9	1.000

c. Land Use Mixed

Entropy Index is used to determine the diversity of land uses. The closer to the value of 1 (one), the area is defined as having a Diversity of land uses that can support the activities and needs of the local community. The various conditions in the study area are as follows:

TABLE VIII. ENTROPY INDEX DI POLEHAN SUB-DISTRICT

No	Neighbourhood	Entropy Index
	Urban Kampong	
1	Neighbourhood 1	0,20
2	Neighbourhood 2	0,23
3	Neighbourhood 3	0,43
4	Neighbourhood 4	0,31
6	Neighbourhood 6	0,47
	Planned Housing	
5	Neighbourhood 5	0,58
7	Neighbourhood 7	0,49
8	Neighbourhood 8	0,36
9	Neighbourhood 9	0,37

In general, organized housing has more variety of land uses. This is mainly dominated by land-use along the main axis road which is widely used for trade, services, educational facilities and health facilities. This condition is also due to the fact that organized residential areas tend to be more open to the circulation of vehicles that are captured by the public as a potency for economic development.

B. Physical Sustainability

a. Physical Sustainability Status Analysis

Based on the analysis of Rapfish MDS using Software R, it was found that the neighbourhood in Polehan Sub-district has a reasonably sustainable and less sustainable status. In general, urban forms in organized housing are more sustainable. However, both of them still need to be improved.

TABLE IX. PHYSICAL SUSTAINABILITY STATUS INPOLEHAN SUB-DISTRICT

No	Neighbourhood	Physical Sustainability Index	Sustainability Status
	Urban Kampong		
1	Neighbourhood 1	52.87%	Fairly sustainable
2	Neighbourhood 2	53.81%	Fairly sustainable
3	Neighbourhood 3	49.78%	Less Sustainable
4	Neighbourhood 4	55.06%	Fairly sustainable
5	Neighbourhood 6	48.50%	Less Sustainable
	Planned Housing		
6	Neighbourhood 5	51.07%	Fairly sustainable
7	Neighbourhood 7	50.23%	Fairly sustainable
8	Neighbourhood 8	51.14%	Fairly sustainable
9	Neighbourhood 9	59.24%	Fairly sustainable

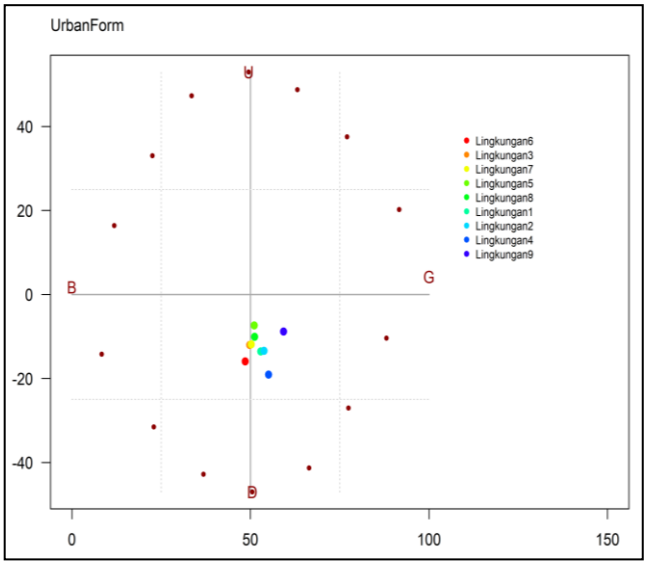

Fig. 1. Physical Sustainability Status in Polehan Sub-district

b. Leverage Analysis

Leverage analysis is an analysis to determine the leverage factors for the physical sustainability status in Polehan Sub-district. The results of the leverage analysis on the input dimensions are presented in Fig. 2. The determination of the leverage factors graphically can be seen from the long bar on the attributes.

ISSN No:-2456-2165

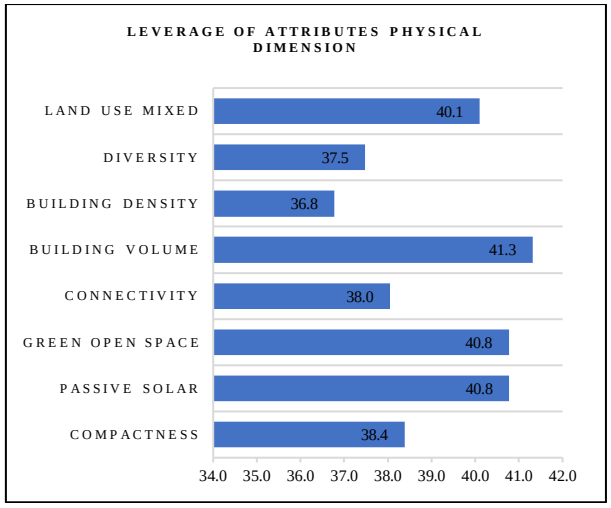

Fig. 2. The leverage factors for the physical sustainability status in Polehan Sub-district

Based on the results of the leverage analysis, the variable "building volume" is the most significant leveraging factor for the sustainability status of the urban form aspect with a root mean square (RMS) value of 41.3. The second biggest leverage factor is the variable green open space, and passive solar design with a root mean square (RMS) value of 40.8. Intervention on these factors can increase the value of the sustainability index. The results show that the building volume needs to increase as well as green open space and passive solar. These leverage factors tend to indicate the development of medium/ high rise buildings where the building volume can increase as well as an increase in land area for green open space.

IV. CONCLUSION

Urban kampong is one of the main components in realizing the sustainability of the city. The shape that tends to be compact and dense is one of the factors that are considered to support this sustainability. However, related to the physical condition of the urban kampong there are still problems that cannot be ignored, one of which is the one in Polehan Kampong. Therefore this research aims to identify the physical characteristics of the urban kampong and the physical sustainability status of the urban kampong.

Based on the results of the research, it was found that several physical factors in the settlement of Polehan Kampong were still below standard, namely the passive solar design, green open space, and connectivity factors. In terms of density and building volume, both are relatively high in Polehan Kampong, but the conditions tend to be developed horizontally and use too much space without providing open space which creates problems. The physical sustainability status in Polehan Kampong is in the category of fairly and less sustainable. This status will undoubtedly have reduced the sustainability of the city. The main leverage factors that can leverage physical sustainability in Polehan Kampong are the building volume attribute, while the next leverage factors are green open space and passive solar design. These results indicate that the building volume needs to be increased by also increasing green open space and passive solar. This result leads to the need for vertical development (medium/high rise). The medium/high rise building could increase the volume of the building so that increase space for dwellings and increase openings to increase in passive solar as well as an increase in land area for green open space development. The development of green open space can also be done through the development of public green open spaces which also function as spaces for socializing and playing for children.

REFERENCES

[1]. United Nations, D. o. (2015). World Urbanization Prospects: The 2014 Revision. New York: United Nations.
[2]. Surjono. (2018). Bumi yang Lestari: Kajian Literatur dan Empiris tentang Perencanaan Pembangunan Berkelanjutan Skala Makro-Mikro. Malang: UB Press.
[3]. Sangalang, I., & Adji, F. F. (2014). Pengaruh Kondisi Hunian dan Lingkungan Terhadap Keberlanjutan Permukiman Tepi Sungai. Studi Kasus : Kampung Pahandut dan Desa Danau Tundai di Kota Palanga Raya. Jurnal Perspektif Arsitektur, Vol.9 No.2, 47 - 58.
[4]. Sumintarsih, & Adrianto, A. (2014). Dinamika Kampung Kota, Prawirotaman dalam Perspektif Sejarah dan Budaya. Yogyakarta: Balai Pelestarian Nilai Budaya (BPNB) Daerah Istimewa Yogyakarta.
[5]. Surjono, S., &Ridhoni, M. (2018). Life satisfaction index and physical sustainability aspects of kampung settlement in Malang, Indonesia. International Journal of Applied Engineering Research (IJAER) 7 (4), 6238-6242
[6]. Jabareen, Y. R. (2006). Sustainable Urban Forms: Their Typologies, Models, and Concepts. Journal of Planning Education and Research, Vol.26, 38 - 52.
[7]. Bardhan, R., Kurisu, K., & Hanaki, K. (2015). Does compact urban forms relate to good quality of life in high density cities of India? Case of Kolkata. Cities, Vol. 48, 55-65.
[8]. Lai, P.-C., Chen, S., Low, C.-T., Cerin, E., Stimson, R., & Wong, P. Y. (2018). Neighborhood Variation of Sustainable Urban Morphological Characteristics. International Journal of Environmental Research and Public Health, Vol.15, No.465, 1-13.
[9]. Maleki, M., Zain, M., & Ismail, A. (2012). Variables communalities and dependence to factors of street system, density, and mixed land use in sustainable site design. Sustainable Cities and Society 3, 46–53.
[10]. Surjono, S., Rahma, F. D. P., Setyono, D. (2020). Sustainability of Thematic Kampongs. International Conference of Heritage & Culture in Integrated Rural-Urban Context (HUNIAN 2019). The University of Brawijaya. Malang.
[11]. Pitcher, T. J., & Preikshot, D. (2001). RAPFISH: A Rapid Appraisal Technique to Evaluate The Sustainability Status of Fisheries. Fisheries Research, 49, 255-270.