Lessons learnt from and sustainability assessment of Indonesian urban kampong

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Abstract. The search of good (sustainable) model of development has been evolved from the era of City Beautiful to current era of uncertainty. Many urban planner and designers practice western modern concept and design, which are not entirely suitable for developing countries. It has been identified that local forms and characteristics in the urban context have wisdom and content that sustainable for local condition. This paper supports the argument that local characteristics have the qualities of sustainable development by evaluating sustainable development indicators and promoting method in generating aggregate indicator of sustainable development qualities of urban kampong in Indonesia. Fuzzy logic approach, which is widely used in system control design, is promoted in formulating the aggregate indicator of sustainable kampong in Indonesia. The result show that Indonesian kampongs are good in compactness, density, and access. Other indicators will also show sustainable development quality if the lacks are improved.

1. Introduction
Kampong (Indonesia/Melayu) is often associated with slum within urban areas, similar to favelas in Brazil or ghettos in western countries. A kampong, therefore, is perceived to carry negative aspects and treated as a slum. Kampongs became places for improvement, upgrading, and renewal or even demolition [1][2]. Kampong Improvement Program (KIP) in Indonesia, launched in 1969, was proclaimed by UN-Habitat as the world’s first slum upgrading program. Urban designers and planners have not been inspired by kampong and its forms in creating new residential areas, even for low income communities. Imported ideas from western and other ‘modern’ developments are more popular to them. Positive aspects of kampongs are overridden by the negative perception that kampong is slum.

There are two issues related to urban kampong in Indonesia. Firstly, social and physical characters of urban kampong convey sustainable development principles. Secondly, approaches to measure level of sustainability of urban kampong through an aggregate indicator. Descriptions of Indonesian kampong’s characters can counterweigh negative perceptions of the ‘Indonesian slums’, several authors identify and explore positive aspects of kampong [3][4]. These authors claimed that Indonesian kampongs are successful in managing aspects of sustainable settlement, i.e. vitality and livability. The authors focused the discussion on social characters of kampong, the so called rukun (social harmony) and gotong royong (mutual cooperation) in creating public places. Rahmi et.al., [4] underlined that Indonesian kampongs possess unique characters that cannot be described into other terms such as slum, squatter, marginal or low income settlement. She continuously argues that kampongs best describe Jane
Jacobs’ humanistic social environment that she called as ‘zoning for diversity’, i.e. urban places that characterized by short blocks, mix-uses, many corners and street corridors defining the sidewalks [5].

The physical characters of ‘zoning for diversity’ are possessed by Indonesian kampons. Characters that guarantee vibrant and livable environment which are required for urban sustainable development. Recent literatures of sustainable development view that sustainability of urban environment may be achieved through several qualities: (1) urban compactness, including density [6][7][8][9][10][11][12]; (2) diversity, including mixed-use [7][10][11]; (3) accessibility [6][7][9][11]; (4) identity [6]; (5) environment [7][8][9][10][11].

Social and physical character of kampong, in terms of their positive aspects, are actually one of the key points of Sustainable Development Goals (SDGs), i.e. ‘sustainable communities and cities’ [13]. Effort to promote sustainable urban dwelling becomes more important since 6 in 10 people will be urban dwellers while today almost one third of urban dwellers in developing countries live in slums [14].

Aggregate indicators to measure social aspects of sustainable development are familiar, such as Human Development Index (HDI) and Multidimensional Poverty Index (MPI) [15]. In terms of community, Putnam’s Social Capital Index is perhaps the best example [16]. Sustainable development indicators of physical aspects of design and planning, however, are currently evaluated partially in terms of its diversity, accessibility, and environment. Several methods that combine several indicators, such as spider model, pentagon prism model, Systeme de Evaluation des Logement (SEL), and meta-regression analysis, are not designed to formulate a composite indicator from selected individual indicators.

This research was aimed to respond these two issues, i.e., to identify physical quality of Indonesian Kampong for several sustainable city indicators, and to formulate an aggregate indicator, which is a composite of physical and social indicators, for sustainable settlement criteria. We use Indonesian urban kampong in Malang City as a case.

2. Methods
Major Two steps analysis were utilized in this research. The first step was qualitative descriptive analyses. Qualitative descriptive analysis was used to measure quality of sustainable characters of urban kampong in Klojen District. Six variables were employed in this step: Compactness, accessibility/permeability, diversity, density, poverty, and community participation. The first four represent physical/environmental qualities, the fifth represents economic capabilities and the last represents social capital.

2.1. Environmental or Physical aspects
Dispersion index or compactness index [17] was used to measure the efficiency in urban utility provision, the scale is ranging from 0 to 1, the closer to 1 the more compact. When the shape is simple (one patch), calculation of compactness index for 2D shapes may use the following formulas:

\[
Ci = \frac{Di}{Di'} \quad \text{and} \quad Di = 2\sqrt{\frac{Ai}{\pi}} \quad \text{or} \quad CILP = \frac{2\pi}{s/p}
\]

Where

\(Ci\) = compactness index

\(Di\) = diameter of a circle with the same area of area \(i\)

\(Di'\) = the longest distance between two points of area \(i\)

\(Ai\) = the area of \(i\) \[18\]

Or

\(CILP\) = compactness index of largest patch

\(s\) and \(p\) = area and perimeter of largest patch \[19\]
To measure connectivity, alpha index is a node-linkage association which measures the ratio of number of circuits relative to maximum number possible in a network [20]. The alpha index ($\alpha$) is calculated as follows:

$$\alpha = \frac{e - v + 1}{2v - 5}$$

where $e = $ number of edges and $v = $ number of nodes. The $\alpha$ values range from 0 to 1.

Diversity in urban landscape is often measured by the variety of land uses. Recent authors stated that mixed land use, which enabled pedestrians to walk to many destinations of diverse land uses in close proximity, is more desired than segregated land uses which are implicated in health and transportation problems [21]. Diversity of land use is often measured by entropy index (EI).

$$EI = \sum_{i=1}^{N} K_i \cdot \log\left(\frac{1}{K_i}\right)/\log(N)$$

where EI is Entropy Index; $K$ is area of land; $N$ is number of land uses.

Building density, as the fourth indicator of physical settlement quality was simply measured by division of numbers of building by area. The density was classified into four: slum (more than 100 buildings/Ha; high density (80-100 buildings/Ha); medium density (30-<80 buildings/Ha); low density (less than 30 buildings/Ha). The classification is based on SNI 1733-2004 (Indonesia National Standard) of urban settlement environmental planning mechanism.

2.2. Economic capabilities

Poverty and community participation measures were utilized to measure social aspects in the study area. Three basic poverty measures were employed in the research: Poverty head count index (Po), poverty gap index (P1) and poverty severity index (P2). General formula to measure poverty is=

$$P_a = \frac{1}{N} \sum_{i=1}^{q} \left(\frac{z - y_i}{z}\right)^a$$

where :

Pa = Poverty head count index (if a=0), or Poverty gap index (if a=1), or Poverty severity index (if a=2); $N$ is total number of population; $q$ is total number of poor population who are living at or below poverty line; $z$ is poverty line; and $y_i$ is the income of the poor individual $i$ [22].

2.3. Social capital

Social capital comprises of trust, norms, and networks, and in Indonesian case, at the village / kampong level, it is related to gender empowerment [23]. In this research, women were prioritized in the sampling process to evaluate the affiliation network as part of social capital [24]. Social sustainability of urban settlement can be measured from community participation in the community’s institution. Rate of participation (RoP) is obtained from sum of diagonal value of adjacency matrix devided by number of institutions.

$$RoP = \frac{sum\ of\ diagonal\ value\ of\ adjacency\ matrix}{number\ of\ institution}$$

where:

Adjacency matrix (A) = I x I' = I(n,m)xI'(m,n). The result of RoP then will be compared to total number of institutions. The closer the value of RoP to total number of institutions the higher community participation to local institutions.
The second step was to formulate a composite index of sustainability of the selected kampong. In this step we inputed discrete indicators obtained from step one. Even though the indicators were not so comprehensive but, at least, they represented three legs of sustainable development i.e. environmental, economic, and social aspects. In formulating a composite index from a set of indicators, fuzzy logic approach, using Matlab-Fuzzy Logic Toolbox, was utilized in the research. The framework is described in figure 1.

![Figure 1. Framework of the model.](image)

Expert judgement was used in the ‘if – then’ fuzzy rules. Assigned normalization for compactness, α, entropy, poverty, and affiliation network indices were classified into 0 – 0.33, 0.34 – 0.66, 0.67 – 1 as low, medium, and high respectively. Particular for poverty, in contrast to other indicators, high means bad. Density was classified into < 30 houses/Ha, 30 – 80 houses/Ha, and >80 houses/Ha as low, medium, and high respectively. Normalization for final aggregate index classified level of sustainability into five: 0.81–1 (high); 0.61-0.8 (medium high); 0.41-0.6 (medium); 0.21–4 (medium low); and 0-0.2 (low sustainability).

3. Results
The analysis resulted in two type of indicators: discrete indicators of urban kampong which shows each indicator of physical entities found in the three kampong and composite indicators as a result of combination of discrete indicators into single composite indicator.

3.1. Discrete indicators of urban kampong
Three kampungs were evaluated: Arab, Pecinan, and Kebalen Kampongs (figure 1). Two kampungs are ordinary urban kampong: Arab and Pecinan kampungs were named for the majority of population, while the third kampong is Kebalen, where most of the dwellers are native people. These three Kampongs are located in Klojen District (central district of Malang City).
The study area: A) Pecinan, B) Arab, C) Kebalen Kampong

The evaluation of discrete indicators of these three kampongs are described in table 1.

Table 1: Discrete Indicators for Physical, Economic, and Social Aspects

| Kampongs: | compactness | A-index | entropy | density | poverty | affiliation network |
|-----------|-------------|---------|---------|---------|---------|---------------------|
| Arab      | 0.73 (good) | 0.63 (moderate) | 0.76 (good) | 0.63 (moderate) | 0.05 (good) | 0.93 (good) |
| Pecinan   | 0.63 (moderate) | 0.34 (moderate) | 0.17 (bad) | 0.58 (moderate) | 0.17 (bad) | 0.57 (moderate) |
| Kebalen   | 0.58 (moderate) | 0.36 (moderate) | 0.26 (bad) | 0.10 (bad) | 0.82 (bad) | 0.30 (bad) |

In terms of sustainable urban form, table 1 shows that Arab Kampong meet criteria of sustainability. Four indicators of urban form show high indices. Social and economic indicators are also high. Overall evaluation shows that Arab Kampong was the highest, then followed by Pecinan Kampong and Kebalen Kampong. Kebalen kampong was the lowest, majority of indicators were low (bad) and today Kebalen is classified as a slum settlement by the Local Government of Malang. The result shows the case in Klojen District in Malang City. In other places the results may be different. It cannot be inferred that between sustainability indicators and race have relationship. However, overall indices prove that kampongs, to some extent, have met sustainability criteria of urban settlement.

3.2. Composite Indicators

To formulate a composite indicator, inference system based on fuzzy rule was utilized. Fuzzy rules use ‘If-then’ languages. Based on figure 1, three steps of inference processes were conducted. The first inference system was to formulate a composite indicator of physical aspect. The second one was for a
composite indicator of social-economic aspect, and the last was for an aggregate sustainability indicator of urban kampong. The inference system for physical aspects was based on 81 permutations of if-then rules (table 2) based on formula \( n^r = 3^4 \) where \( n \) is the number of objects that can be selected and \( r \) is the amount that must be selected.

Table 2: Fuzzy rules for physical aspects (urban form) indicator.

| No | IF compactness’ index is... AND \( \alpha \)-index is... AND Entropy index is... AND density index is... THEN the Physical composite indicator is... (obtained from Delphy analysis) |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | good                                                                                                                                  good                                                                                                                                  good                                                                                                                                             good |
| 2  | good                                                                                                                                  good                                                                                                                                  moderate                                                                              good |
| 3  | good                                                                                                                                  moderate                                                                                                                             good                                                                                                                                             good |
| etc.| -                                                                                                                                     -                                                                                                                                     -                                                                                                                                                -   |
| 80 | good                                                                                                                                  bad                                                                                                                                    bad                                                                                                                                             bad |
| 81 | bad                                                                                                                                    bad                                                                                                                                    bad                                                                                                                                             bad |

The inference of ‘then’ from the result of combination of four indicators (independent variables) was based on Delphi analysis. Defuzzyfying of inputed data resulted in a composite indicator (crisp number) of physical aspects of the form of the three kamongs (table 4).

Composite indicators of social-economic aspects were generated with the same process. Fuzzy rules of social economic aspects consist of 9 possibilities \( (n^r = 3^2) \) (table 3).

Table 3. Fuzzy rules for Social Economic indicator

| No | IF poverty is... AND affiliation network is ... THEN the social – economy composite indicator is ...(obtained from Delphy analysis) |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | good                                                                                                                                  good                                                                                                                                  good                                                                                                                                             good |
| 2  | good                                                                                                                                  moderate                                                                              good |
| 3  | moderate                                                                               good                                                                                                                                  good |
| 4  | moderate                                                                               moderate                                                                              moderate |
| 5  | bad                                                                                                                                    good                                                                                                                                  moderate |
| 6  | good                                                                                                                                  bad                                                                                                                                    moderate |
| 7  | bad                                                                                                                                    moderate                                                                              bad |
| 8  | moderate                                                                               bad                                                                                                                                    bad |
| 9  | bad                                                                                                                                    bad                                                                                                                                    bad |

Defuzzification of the composite indicators of social economic aspects results in crisp number is shown in table 4.

Table 4: Defuzzyfication of Composite indicators for physical aspect (urban form) and social economic aspects

| No | Kampong         | Physical aspect (urban form) | Social – economic aspects |
|----|-----------------|------------------------------|--------------------------|
| 1  | Arab Kampong    | 0.520                        | 0.740                    |
| 2  | Pecinan Kampong | 0.474                        | 0.612                    |
| 3  | Kebalen Kampong | 0.440                        | 0.445                    |

The last process was to formulate an aggregate indicators from the two composite indicators above. The inference system or the rule base to define the level of sustainability was based from Delphi method obtained from key experts in urban development. As in social economic indicators, eight possibilities (table 5).
Table 5: Rule base of urban kampong sustainability

| IF physical sustainability is.... | AND social – economic sustainability .... | THEN the aggregate sustainability indicator is.... |
|----------------------------------|----------------------------------------------|-----------------------------------------------|
| good                             | good                                         | High                                          |
| good                             | moderate                                     | Medium – high                                 |
| moderate                         | good                                         | Medium – high                                 |
| moderate                         | moderate                                     | Medium                                        |
| good                             | bad                                          | Medium – high                                 |
| bad                              | good                                         | Medium                                        |
| bad                              | moderate                                     | Medium – low                                  |
| moderate                         | bad                                          | Medium – low                                  |
| bad                              | bad                                          | Low                                           |

The determination of high, medium-high, medium, medium – low, and low is based on the set membership. The equation of levels of high sustainability is based on the increasing line of the curve, while for low sustainability is on the opposite way. and the membership of medium-high, medium, and medium-low is based on the equation of triangle area of the curve. The equations of the membership are as follow:

High sustainability = 0.5 ≤ X ; (X – 0.5) / (1-0.5); x ≤ 1
Medium – high sustainability = 0.5 ≤ X or X ≤ 1; (X – 0.5)/(0.75 – 0); (0.5 – X)/(1-0.5)
Medium sustainability = 0.25 ≤ X or X ≤ 0.75; (X – 0.25)/(0.5 – 0); (0.5 – X)/(0.75 – 0.5)
Medium – low sustainability = 0 – X or X – 0.5; (X – 0) / (0.25 – 0); (0.35 – X)/(0.5 – 0.25)
Low sustainability = 0 ≤ X; (0.2 – X)/(0.2 – 0); X ≤ 0.2.

Defuzzifying of two composite indicators, physical and social-economic indicators, into an aggregate indicator of sustainable kampong indicates that Arab kampong is more sustainable than the other two kampongs (table 6).

Table 6: Sustainability level of the three kampong in Malang

| Kampong | Score | Sustainability level |
|---------|-------|----------------------|
| Arab    | 0.621 | Medium - High        |
| Pecinan | 0.548 | Medium               |
| Kebalen | 0.457 | Medium               |

4. Conclusion
Most of discrete indicators of sustainability in the three kampongs in Malang were good and fair. Bad indicators were found at the entropy of Pecinan and Kebalen Kampongs, while bad indicators of poverty and participation level found in Kebalen Kampong. The evaluation of discrete indicators shows that kampongs are good examples of sustainable settlements in the form of their compactness, density, and access. The composite indicators of their environment were scored in the range of 0.44 to 0.52, while the composite indicators of social-economic aspects were in the range 0.445 to 0.740. Finally, the aggregate of all indicators were in the range from medium to medium – high.

From the results, we promote that this mechanism of assessment can be improved to involve more comprehensive indicators. The good characters of Indonesian urban kampong must be explored further more to provide models for the new local post-modernism planning in the era of new urbanism. These characters of sustainable kampong can be expanded into practices at larger scale in urban context. Of course, more research must be accomplished in determining the ‘acceptable zone’ of compactness, density, entropy, access and other indicators of sustainable / livable place for all scale of urban development from micro, mezo, to macro settlement.
References

[1] Darrundono, D. A., & Tirtamadja, B. A. (2000). Kampong Improvement Program III. International Workshop on Kampong Improvement Program: Lessons Leading to Strategies for the Future (p. 169 pages). Jakarta: Provincial Government of Jakarta.

[2] Wang, D. D. (2016). Urban Villages in the New China: Case of Shenzhen. NY: Palgrave Macmillan.

[3] Rahmi, D. H., Wibisono, B. H., & Setriawan, B. (2001). Rukun and Gotong Royong: Managing Public Spaces in an Indonesian Kampong. In P., Miao, Public Places in Asia Pasific Cities (pp. 119-134). Honolulu: Kluwer Academic Publishers.

[4] Evers, H.-D., & Korff, R. (2003). Southeast Asian Urbanism: The Meaning and Power of Social Space. London: Lit-Verlag.

[5] Jacobs, J. (1961). The Death and Life of Great American Cities. NY: Random House.

[6] Ye, H., He, X. Y., Song, Y., Li, X., Zhang, G., Lin, T., & Xiao, L. (2015). A sustainable urban form: The challenges of compactness from the viewpoint of energy consumption and carbon emission. Energy and Buildings, 90-98.

[7] Wu, J. (2006). An analysis of sustainable urban form in Dalian, China. Thesis. Waterloo, Ontario, Canada: University of Waterloo.

[8] Holden, E. (2004). Ecological footprints and sustainable urban form. Journal of Housing and the Built Environment, 19(1), 91-109. Retrieved 04 12, 2016, from http://www.jstor.org/stable/41107246.

[9] Masoumi, H. E. (2014). A Theoretical Approach to Capabilities of the Traditional Urban Form in Promoting Sustainable Transportation. Theoretical and Empirical Researches in Urban Management, 9(1), 44-60.

[10] Mousavi, S. M., & Nazarian, A. (2013). Urban Form and Sustainable Development: The Case Study of Tehran City. 2nd International Scientific Conference on Economic and Social Development (pp. 592-600). Varazdin: VADEA.

[11] Chen, H., Jia, B., & Lau, S. S. (2008). Sustainable urban form for Chinese compact cities: Challenges of a rapid urbanized economy. Habitat International(32), 28-40.

[12] Jabareen, Y. R. (2006). Sustainable Urban Forms Their Typologies, Models, and Concepts. Journal of Planning Education and Research, 26-38. doi:DOI: 10.1177/0739456X05285119

[13] United Nations. (2015). Transforming Our World: The 2030 Agenda For Sustainable Development. NY: UN. Retrieved from sustainabledevelopment.un.org

[14] United Nations. (2016). The Sustainable Development Goals Report 2016. NY: UN.

[15] De Muro, P., Mazziotta, M., & Pareto, A. (2012). Composite Indices for Multidimensional Development and Poverty: An Application to MDGs Indicators. Social Indicator Research, 1-18. doi:doi:10.1007/s11205-010-9727-z.

[16] Webster, R. (2013). The Dimensions of Social Capital. Thesis. Orlando, Florida, USA: University of Central Florida.

[17] Kotharkar, R., Bahadure, P., & Sarda, N. (2014). Measuring Compact Urban Form: A Case of Nagpur City, India. Sustainability, 4246-4272. doi:10.3390/su6074246.

[18] Li, W., Goodchild, M. F., & Church, R. L. (2013). An Efficient Measure of Compactness for 2D Shapes and Its Application in Regionalization Problem. Tempe: Arizona State University.

[19] Gradinaru, S. R., Ioja, C. I., & Patru-Stuparoiu, I. (2015). Do Post Socialist Urban Areas Maintain Their Sustainable Compact Form? Romanian Urban Areas as A Case Study. Journal of Urban and Regional Analysis, 129-144.

[20] Rodrigue, J.-P. (2013). The Geography of Transport System. New York: Routledge.

[21] Brown, B., Yamada, I., Smith, K., Zick, C., Kowaleski-Jones, L., & Fan, J. (2009). Mixed land use and walkability: Variations in land use measures and relationships with BMI, overweight, and obesity. Health & Place, 1130-1141. doi:10.1016/j.healthplace.2009.06.008.

[22] Haughton, J., & Khandker, S. (2009). Handbook on Equality and Poverty. Washington: The World Bank.
[23] Surjono, Prasisca, Y., & Sutikno, F. (2015). Gender Equality and Social Capital as Rural Development Indicators in Indonesia (Case: Malang Regency, Indonesia). Procedia - Social and Behavioral Sciences, 370-374. doi:doi: 10.1016/j.sbspro.2015.11.048.

[24] Carrington, P., Scott, J., & Wasserman, S. (2004). Models and Methods in Social Network Analysis. New York: Cambridge University Press.