Mapping Informal Settlements Using Geospatial Method

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Abstract. As one of the largest city in Indonesia, Bandung faces informal settlement, or “Permukiman Kumuh” problems. Based on the criteria of informal settlements used in KOTAKU Program, Bandung contains 8.7 percent of slums within it. During its development, these informal settlements experiences phase based on the development of the city, which are infancy, consolidation and saturation. Each developmental phase needs differing solutions. This study formulates the spatial development phases from the informal settlements in Bandung through Geospatial methods to give new perspective in settling informal settlement problems.

Keywords: informal settlements, spatial phases, models

1. Introduction to Informal Settlements in Indonesia

Informal settlement is a serious and common problem in Third World Countries (Nassar & Elsayed, 2017). UN-Habitat (2008) defined informal settlements in three types: (1) slum: a neighborhood of housing that was once in good condition but has since deteriorated or been subdivided into a state of high crowding and rented out to low-income groups; (2) squatter: an area of poor quality housing built on illegally occupied land; and (3) An irregular subdivision, in which the legal owner subdivides the land into sub-standard plots and sells or rents them out without following all relevant building bylaws. UN-Habitat (2008) also defines the informal settlements as a group of household who live under the same “roof” in urban areas which lack one or more of these conditions: durable housing, sufficient living area, access to clean water, access to proper sanitation and security of tenure.

Informal settlements grow along with the development of the city (Fakade, 2000). There are three phases of informal settlements growth (Abebe, 2011): infancy, consolidation and saturation. The phases of informal settlements showing the formation and level of the informal settlements. These phases are analyzed based on spatial characteristics of the informal settlements.

In Indonesia, informal settlements have become one of the problems that get special attention from the government. In Indonesia, informal settlements are also known as “Permukiman Kumuh’. Permukiman Kumuh is inhabitable settlements because of the high density of the buildings and the quality of buildings and facilities and also infrastructures that do not meet the requirements (Minister of Public Works and Public Housing Regulation Number 02/PRT/M/2016). One of the efforts by the government to resolve informal settlements’ problems is through a program, called KOTAKU program. KOTAKU or Kota Tanpa Kumuh (City without Slums) program is a Minister of Public Works and Public Housing owned program that accelerates the handling of informality in Indonesia and also support the “100-0-100 movement”, namely 100% universal access to drinking water, 0% of slums (permukiman kumuh), and 100% of access to proper sanitation.
KOTAKU program handles informality by building collaboration platforms through increasing the role of local government and community participation. Almost every city in Indonesia has informality which belongs to the KOTAKU program. An informality belongs to the KOTAKU program based on the criteria: buildings, local streets, drinking water supply, community drainage, wastewater management, garbage management, and fire protection. In handling the informality which belongs to KOTAKU program, the government have several handling patterns, they are restoration, rejuvenation and re-settlement.

In handling the informality, it should be known at what phases the informality settlements occur because the phases can help to determine which handling patterns are possible to do. Hence, this study aims to formulate the model of informal settlements phases based on their spatial characteristics as one of the informal settlements criteria. This study will use GIS as a tool of analysis. Taking Bandung as a case, which is the third most inhabited cities with a population around 2.5 million citizens and the second highest population living in slums (Anindito, 2017 citing Tarigan et al, 2015), this study should suggest the possible model of informality.

2. Study Area

Bandung City is one of the largest cities in Indonesia, having the total area of 167.31 km² with 2.497.938 people (BPS,2018) (approximately 14.930 people/km²). Based on the Mayor’s Decree number 648/Kep.286-DisTarCip/2015 regarding the establishment of informal settlements and housing environment locations, there are 454 slums areas in Bandung with the total area of 1,457.45 Ha (8.7 percent of Bandung total area). Based on this decree, the slums were divided into three planning target areas, which are:

1. Accelerated Slum Areas, including 15 areas with the total area of 448.9 Ha.
2. Slum Areas, including 106 areas with the total area of 963.91 Ha.
3. Slum Prevention Areas, including 30 areas with the total area of 44.64 Ha.

The following map shows the spread of slums in Bandung based on Mayor’s Decree number 648/Kep.286-DisTarCip/2015 regarding the establishment of informal settlements and housing environment locations.

![Figure 1. Slums Area in Bandung](image_url)
3. Methodology

3.1. Criteria, Indicator and Data

The criteria that are used for this study are based on the phases of informality development (Abebe, 2011; Sori, 2012).

1. **Infancy/ starting stage:** the initial occupancy stage where patches of the vacant land, like on step sided land, swamps, near river banks, hazardous areas, conserved areas, etc, become available to the slum dwellers. They can also occur in suitable lands. In this phase, the vacant land consist of at least 50 percent of the land is used for housing.

2. **Consolidation stage:** the intermediate stage between infancy and saturation. There is fast outward expansion and the available land will be reduced by filling up additional buildings. About 80 percent of the land would be used for housing.

3. **Saturation stage:** this stage whereby additional construction is primarily through vertical development because of the vacant lands gets filled up. At this stage, overcrowding is highest and lowers the living standards of slum dwellers.

From the definition of the phases, the keyword of staging the phases are vacant land and residential density. Therefore, spatial data that can be used to formulate the model of the development phase of informality are the geographic and the built-up area map (land use and buildings) of Bandung City. Because of Bandung City does not have a standard of building density per area, comparisons between areas in the city are used to categorise the phasing in each area. For example, if an area has the building density \(d_1\) which is larger than the density in other areas \(d_2\), \(d_1\) can be categorised as having a higher level of informality (consolidation or saturation).

3.2. Model Formulation

The following indicators shown on the table below will be used to formulate the classification model based on the informality growth phase.

| Datum | Indicator |
|-------|-----------|
| Percentage of built areas (%) | The higher the percentage of built areas, the higher the phase |
| Percentage of undeveloped areas (vacant land) (%) | Vacant land > 50% = Infancy |
| | 50% > Vacant land < 80% = Consolidation |
| | Vacant land <20% = Saturation |
| Areas used for housing (m²) | The more areas used for housing, the higher the phase |
| Building Density (units./ Ha) | The higher the building density, the higher the phase |

For mapping the informal settlement using geospatial methods, carried out in the following stages:
Area delineation for parts defined as slum areas based on DPKP3 of Bandung City (2017)

- Count the area of each slum areas
- Overlay the building and area shapefiles within the slum areas
- Clip the building shapefile with the area shapefile within the slum areas
- Count the area of each slum areas
- Identify the building types included in slum areas
- Count the number of buildings in each slum areas
- Count the area for built area in slum areas
- Percentage of built areas
  - The higher percentage of built areas, the higher the phase
- Percentage of undeveloped areas
  - The higher percentage of undeveloped areas, the lowest the phase
- Area used for housing
  - The more areas used for housing, the higher the phase
- Building density
  - The higher the building density, the higher the phase
- Classify the slum areas (infancy, consolidation, or saturation)

Figure 2. Staging of Geospatial Method

4. Result
Based on existing data of buildings in Bandung, in each slums area is more than 70 percent of the buildings are residential. From the Figure 3. Almost all areas in each slum areas are covered by buildings. The density of buildings in each slum area is more than 50 units/ hectare and residential land use are dominates in almost all areas.

Based on the results of building density and land uses, 70 percent of slums area in Bandung is classified as the saturation phase. This phase is the last phase of informal settlement development. Based in this saturation phase, the condition of informal settlements in Bandung are in bad condition because they have the highest density of informal settlement. The density will trigger a decrease in quality of facilities and infrastructures. Also will causes the decrease of environmental quality in that area.

In area on the consolidation phase, the vacant lands (undeveloped area) are mostly form of abandoned land or shrubs. That condition will trigger people in that area to build the land become residential area. So that, the slums area in the consolidation phase also have potential to become saturation phase.
Figure 3. Buildings Map in Slums Area

Figure 4. Phases of Slums Area in Bandung
5. Conclusion and Recommendations

More than 70 percent of informal settlements in Bandung are in the saturation phase. This phase represents that informal settlement conditions in Bandung are in poor condition. Judging from its phase, informal settlement in Bandung has developed from long time ago. The high density in informal settlement has triggered the decrease of facilities qualities. In informal settlement which is in the consolidation phase, there is potential to develop into saturation phase.

To prevent the growing number and phase of informal settlements in Bandung to the worse condition, Bandung government needs to determine the priority of handling informality based on their level. In informal settlement in the latest phase, it may takes action form the government to re-settlement the slums. So that the people in that area can get better quality of environment. Whereas for informal settlement which is in the infancy and consolidation phase, it is necessary to monitor and anticipate from the government they do not grow to higher phase, especially monitoring in land use. In both phases, it is still possible to use restoration and rejuvenation handling patterns to organize the informal settlement. This research can provide a new knowledge that there are staging of informality development and the development in each area is different. So, the government cannot always provide the same solution in handling the informality. City characteristics should be considered in determining the standards for informality phase category for that peculiar city.

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