The Study of Urbanization Effect on the Land Use Changes and Urban Infrastructures Development in the Metropolitan Areas, Thailand

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Abstract. Bangkok has expanded considerably between 1991 - 1996. Which, the key factors contributed to the expansion consisted of real estate, business development and manufacturing industry. The horizontal expansion continued until 1991, after that Bangkok has increased its vertical expansion, especially in the inner and urban areas. The increasing in term of population causes the inner zone growth with high concentration rate, however, the suburban areas are characterized as of urban sprawls with the major expansion of road network. Those connectivities cut through the heart of Bangkok with the surrounding provinces. Currently, Bangkok has been continued its expansion in all directions, with high number of private cars and less users’ choices for public transportation, wich resulted in land-use changes, pollution, and traffic problems. The objective of this research is to study pattern of urban expansion and rate of changes in land use and infrastructure development by analyzing the land use changes in Bangkok and metropolitan and infrastructure development during the past 10 years, 2009 – 2019. The comparing of growth can be performed based on the study of satellite imagery, Path 129 Row 50 and Path 129 Row 51. From the result of analysis, it was found that road intersection density had an effect of the urban density areas. Finally, the Land Change Modeler (LCM) was used to explore and recommend for the appropriate ways for urban planning and development corresponding to the changes and responsive to the people in more sustainable way.
1. Introduction

Urbanization, is one of the megatrends that are emerging recently. In 2030, 61% of the global economy will be economic based activities from 750 cities [1]. This accounts for 22 percent of the world's cities that will attract the growing population of the city from 50 percent today to 72 percent by 2050 [2]. Moreover, by comparing all megatrends, urbanization, apart from being the most likely phenomenon in the future, is also considered as the major factor that will have the highest impact on the world economy [3]. This is partly due to technological advances that will promote future urban efficiency. Bangkok tends to represent as a city on the rise with an increasing population that is more urban than the scope of government. Urbanity of Bangkok has expanded to neighboring provinces such as Nonthaburi, Samut Prakan, Pathumthani [4]. It is interesting that the increasing in number of housing significantly corresponds to the period of urban and infrastructure development, especially the rail transit and public transport system. The impact of Bangkok's rapid urbanization has resulted in not only housing choices but housing groups expanding along the suburbs. Condominiums has also expanded and allocated along the transportation development line, especially along railway networks. As a result, the travel demand for suburban residents has been increasing with traveling for longer distances and times. The continued expansion of urban areas is a major factor affecting land-use change significantly. Over the past 10 years, agricultural areas have rapidly transformed into community development and commercial areas. In response to the expansion of major cities such as Bangkok, Chiang Mai, Khon Kaen, etc [5]. At the same time, the expansion of metropolitan of Bangkok has inevitably expanded into the vicinity areas of contact. Land use has been changed dramatically without appropriate planning which cause in problems of several social and environmental dimensions such as traffic problems, pollution problems, garbage, and sewage problems [6].

From such issues, it can be expected that the expansion of the city and the infrastructure system has the same direction of its impacts. However, with a comprehensive and more accessible to infrastructure, it will lead to noticeable growth of a dense concentration of the center and its surrounding areas. Thus, this research, it focused on how urban expansion had been influenced by infrastructure changes which was measured by an assessment of the road pattern affecting the distribution of city growth. Furthermore, the objective of this study is to identify the changes in the study areas in term of patterns of urban expansion and the rate of land use change and infrastructure development. The study was based on an analysis of land use changes in the focused areas and infrastructure systems over the past 10 years (2009-2019) of Bangkok and its suburbs.

2. Literature Review

2.1 Urbanization in cities

The development of a type of area, known as "big city" or "city" after World War II was one of the social inventions of modernity with the aim of making big cities as a center of political, economic, social and cultural power [7]. The expectation of urban development is to create prosperity in the form of a big city which urban prosperity will expand to various parts of society and enable society as a whole to equally develop [8]. Nevertheless, urbanization could not create the above conditions equally in all areas. Due to urbanization, many cities and megacities are lack of a systematic development plan, this effect caused a state of uncontrollable urbanization and bring up the issue of the development model of problematic and unable to produce the target development of the model [9].

The urbanization of the city and the metropolis began to become noticeable as the city population continued to increase. This can be seen from the proportion of the world population in 1990 which was estimated to 43% or 2.3 billion people living in the metropolitan area, while in 2015 the population increased to about 54% or 4 billion people [10]. Choice of residential locations in urban areas is not equally spread in all areas in the same proportion throughout the world. In some areas, it is also reported that there is a decrease in urban development conditions. The most populated urban areas are in the
region of Asia, followed by Europe, Africa and Latin America [11]. It can be noticed that the conditions that contribute to urbanization in Asian cities and megacities are economic factors which is accented about double impact. With the trend of rapid increasing will lead to several problems of land, housing and energy consumption, etc. The increase in the population of urban areas will contribute to the increase in the number of cities and towns. The metropolis is an area of more than 10 million inhabitants. In 1995, there were 22 cities and 14 megacities, while in 2015 there were 44 cities and 29 cities which has been indicating a double increase in cities and towns. For 20 years (2000-2020), most of the megacities were located in developing countries and it is likely to develop into cities in other parts of Asia, Latin America and Africa, where the cities are expected to become megacities in 2030.

Urbanization is therefore an issue that civil society, governments and international organizations must recognize that urbanization plays an important issue in urban development [12]. Since it can bring the potential of urbanization to economic development in the form of a new model that focuses on the environment and culture as well as the way of life of people in society. This is contradicted to the past which was mostly focused on bringing the conditions of urbanization to be the only factor considering in economic development [13].

2.2 Relationship between road network and urban
To analyze the context of land use and road networks, the key element to be considered is to understand its relationship in the design of traffic appropriately in response to the spatial characteristics. This is because the various elements of urban factors are diverse, particularly land use types, urban form, density, topography which differs by characteristics of the urban morphology based on roadway characteristics, the size of network, and the road section characteristics. Furthermore, the road design must be consistent with the urban pattern due to the reason that transportation is a key factor in supporting urban expansion [14]. The hierarchy of network is different depending on the usage pattern of particular area. Thus, different hierarchy of connection must be designed to connect in connections appropriate accessibility within the city and corresponding to different level of connectivity between the cities [15].

3. Data and Methods
3.1 Study area
The study area is covered the Bangkok Metropolitan Area and its vicinities which consists of 6 provinces, including Nakhon Pathom, Pathumthani, Nonthaburi, Samut Prakan, Samut Sakhon, and Bangkok as depicted in Figure 1. By using geographic information technology, remote sensing techniques of Landsat TM Image Resolution 30 meters was applied for the analysis. In the 2009 analysis, the Landsat 5 TM satellite image was used, and the 2019 Landsat-8 OLI/TIRS system was adopted due to the availability from http://earthexplorer.usgs.gov/. The US Geological Survey (USGS) based images during the dry season and pictures without clouds was selected for by using the combination of images from Band 1-7, images of Path129 Row50 and Path129 Row51, covering Bangkok and surrounding areas.
3.2 Data specifications and preprocessing steps
Satellite images, which have advantages of high resolution, atmospherically corrected, consistent, and fast updating, are selected as data sources in this study. Three cloud-free (<10 %) from Landsat Level 2 was retrieved for year 2009 (Landsat 5 TM), 2014 (Landsat 5 TM), and 2019 (Landsat 8 OLI/TIRS) from the United States Geological Survey (USGS) Earth Explorer which are employed to produce LUC and Road maps (Table 1). To avoid the temperature influence, all the Landsat images are taken in the same month (September) with 30 m. spatial resolution. The multispectral bands from Landsat 5 TM and Landsat 8 OLI/TIRS are expressed as surface reflectance as explained in Table 1.

Table 1. Landsat data (2009, 2014, and 2019).

| Data type     | Date acquired | Season | Path/Low     |
|---------------|---------------|--------|--------------|
| Landsat 5 TM  | 19/01/2009    | Winter |              |
| Landsat 5 TM  | 17/11/2014    | Winter | 129/50 and 129/51 |
| Landsat 8 OLI/TIRS | 17/12/2019 | Winter |              |

Source: United States Geological Survey (USGS), 2020

3.3 Image classification
Maximum likelihood supervised method is widely used for Landsat image classification. It can be classified pixels into several land-use categories based on the character of training data using the three satellite images as demonstrated in Figure 2. Training samples are collected as characteristic features based on visual interpretation from the study area. Considering the four land-use categories, the analysis includes: built-up, green, water, and others. Settlements, roads, residential areas, and some constructed areas are classified in the built-up category. Green space consists of forest and grass, including white poplar, silver birch, brush, roadside green space, and green parks. Rivers, lakes, and water body are comprised as the water class.
3.4 Data analysis

1. Satellite imagery of Landsat-5 TM systems and Landsat-8 OLI / TIRS systems Path / Row 129/50 and 129/51 are employed from the Development Agency, Space Technology and Geospatial (Public Organization) and the website http://earthexplorer.usgs.gov/ of the US Geological Survey (USGS), by selecting images during the dry season, and images without clouds.

2. Geometric Correction is allowed for adjustments to Landsat satellite imagery and directional accuracy which can be referenced to topographic map data with a 1: 50,000 scale of the Royal Thai Survey Department. Then, setting the ground control point (Ground Control Point: GCP) throughout the image and select the clearly visible points both on the satellite image data and terrain map.

3. Satellite image can be performed for classification by means of object-based image classification (classification) by using e-Cognition Developer program and displaying satellite imagery of Band 4, 5 and 3 (Red Green Blue). By selecting Algorithm for segmentation. (Segmentation) multi-level resolution (Multiresolution), the parameters used are Scale of 30, Shape of 0.3 and compactness of 0.4 for the method of nearest neighbor classifier.

4. Determination of the training data set of land use and land cover for each type was input for data classification. In this study, land use and land cover were classified into seven categories: housing and buildings, agricultural area, forest area, grassland and cedar aquaculture areas, water bodies and other areas.

5. Export data in the form of GIS attributes, calculation and analysis of land use data can be analyzed based on photographs.

6. Analyze changes in land use and soil cover by using Land Change Modeler (LCM) for Ecological Sustainability. It is a part of the IDRISI Selva program which is a model capable of Change
Analysis, Transition Potential and Change Prediction. The results can be analyzed from land use data and soil cover for two periods which was used to predict future changes.

7. The results of analysis were classified into 3 levels of urban expansion: Low, Medium, and High, from 1,000 * 1,000 meters grids.

8. Analyze the relationship between urban areas and road patterns by spatial relationship analysis.

9. Recommendation for promoting area based development from understanding road patterns affecting the expansion of urban areas can be performed.

**Figure 3. Conceptual framework.**
4. Results of Analysis

4.1 Land use change in 2009, 2014, and 2019

From the study of land use changes in Bangkok and its vicinity by using imagery from Landsat5 and Landsat 8 satellites (2009 – 2019) with supervise classification, the region can be classified into four classification of area: built-up, green, water, and others as follows.

4.1.1 Land use change in 2009

![Figure 4. Land use in 2009.](image)

| Province              | Built-up (sq.km.) | %    | Green (sq.km.) | %    | Water (sq.km.) | %    | Others (sq.km.) | %    | Total       |
|-----------------------|-------------------|------|----------------|------|----------------|------|----------------|------|-------------|
| Bangkok               | 737.05            | 46.77| 597.90         | 37.94| 74.55          | 4.73 | 166.35         | 10.56| 1,575.85    |
| Nakhon Pathom         | 540.88            | 25.32| 1,266.12       | 59.26| 96.67          | 4.52 | 232.88         | 10.90| 2,136.54    |
| Nonthaburi            | 205.50            | 32.25| 389.78         | 61.17| 11.05          | 1.73 | 30.88          | 4.85 | 637.20      |
| Pathumthani           | 396.29            | 26.09| 918.26         | 60.46| 29.31          | 1.93 | 174.84         | 11.51| 1,518.70    |
| Samut Prakan          | 302.60            | 30.89| 389.91         | 39.81| 204.45         | 20.87| 82.58          | 8.43 | 979.54      |
| Samut Sakhon          | 239.35            | 27.21| 447.33         | 50.86| 161.91         | 18.41| 30.91          | 3.51 | 879.49      |
| **Total**             | **2,421.66**      | **31.34**| **4,009.30**  | **51.88**| **577.94**  | **7.48**| **718.43**    | **9.30**| **7,727.33**|

Land use changes in 2009 showed that the built up area in Bangkok was represented the highest number of 737.05 sq.km. or 46.77 percent. On the other hand, the lowest built up area was Nonthaburi and, the highest green area was Nakhon Pathom of 1,266.12 sq.km. or 59.26 percent. The highest water source was represented by Samut Prakan (204.45 sq.km. or 20.87 percent) which consisting of water and aquaculture areas. The other type of landuse, it was foud that the most mixed area is Nakhon Pathom, where buildings density are concentrated in Bangkok, while green areas are scattered on the outskirts of Nakhon Pathom as depicted in Table 2 and Figure 4.

4.1.2 Land use change in 2014

Land use changes in 2014 showed that the built up area in Bangkok was represented the highest number of 773.07 sq.km. or 49.06 percent. On the other hand, the lowest built up area was Nonthaburi and the highest green area was Nakhon Pathom of 1,283.04 sq.km. or 60.05 percent. The highest water source was represented by Samut Prakan (137.17 sq.km. or 14.00 percent) which consisting of water and aquaculture areas. The other type of landuse, it was foud that the most mixed area is Nakhon Pathom,
where buildings density are concentrated in Bangkok, while green areas are scattered on the outskirts of Nakhon Pathom as depicted in Table 3 and Figure 5.

![Figure 5. Land use in 2014.](image)

**Table 3.** Land use classification in 2014.

| Province           | Built-up (sq.km.) | Green (sq.km.) | Water (sq.km.) | Others (sq.km.) | Total |
|--------------------|-------------------|----------------|----------------|----------------|-------|
| Bangkok            | 773.07            | 656.01         | 47.55          | 99.23          | 1,575.85 |
| Nakhon Pathom      | 490.31            | 1,283.04       | 79.23          | 283.95         | 2,136.54 |
| Nonthaburi         | 244.51            | 300.46         | 10.10          | 82.13          | 637.20  |
| Pathumthani        | 455.09            | 898.04         | 24.22          | 141.35         | 1,518.70 |
| Samut Prakan       | 468.12            | 314.09         | 137.17         | 60.16          | 979.54  |
| Samut Sakhon       | 281.09            | 432.03         | 103.67         | 62.71          | 879.49  |
| **Total**          | **2,712.19**      | **3,883.68**   | **401.93**     | **729.53**     | **7,727.33** |

4.1.3 *Land use change in 2019*

Land use changes in 2019 showed that the built up area in Bangkok was represented the highest number of 894.39 sq.km. or 56.76 percent. On the other hand, the lowest built up area was Nonthaburi and the highest green area was Nakhon Pathom of 1,003.15 sq.km. or 46.95 percent. The highest water source was represented by Samut Prakan (254.58 sq.km. or 25.99 percent) which consisting of water and aquaculture areas. The other type of landuse, it was found that the most mixed area is Nakhon Pathom, where buildings density are concentrated in Bangkok. Green areas are scattered on the outskirts of Nakhon Pathom as depicted in Table 4 and Figure 6.
Figure 6. Land use in 2019.

Table 4. Land use classification in 2019.

| Province        | Built-up (sq.km.) | %   | Green (sq.km.) | %   | Water (sq.km.) | %   | Others (sq.km.) | %   | Total          |
|-----------------|-------------------|-----|----------------|-----|----------------|-----|-----------------|-----|----------------|
| Bangkok         | 894.39            | 56.76| 461.81         | 29.31| 82.81          | 5.25| 136.84          | 8.68| 1,575.85       |
| Nakhon Pathom   | 641.07            | 30.01| 1,003.15       | 46.95| 201.36         | 9.42| 290.96          | 13.62| 2,136.54       |
| Nonthaburi      | 264.82            | 41.56| 295.31         | 46.34| 15.29          | 2.40| 61.78           | 9.70 | 637.20         |
| Pathumthani     | 490.78            | 32.32| 737.30         | 48.55| 44.50          | 2.93| 246.11          | 16.21| 1,518.70       |
| Samut Prakan    | 480.30            | 49.03| 178.14         | 18.19| 254.58         | 25.99| 66.52           | 6.79 | 979.54         |
| Samut Sakhon    | 289.69            | 32.94| 371.52         | 42.24| 202.93         | 23.07| 15.36           | 1.75 | 879.49         |
| Total           | 3,061.05          | 39.61| 3,047.24       | 39.43| 801.47         | 10.37| 817.56          | 10.58| 7,727.33       |

Table 5. Summary of land use changes in 2009, 2014, and 2019.

| Type       | 2009      | %   | 2014      | %   | 2019      | %   |
|------------|-----------|-----|-----------|-----|-----------|-----|
| Built-up   | 2,421.66  | 31.34| 2,712.19  | 35.10| 3,061.05  | 39.61|
| Green      | 4,009.30  | 51.88| 3,883.68  | 50.26| 3,047.24  | 39.43|
| Water      | 577.94    | 7.48 | 401.93    | 5.20 | 801.47    | 10.37|
| Others     | 718.43    | 9.30 | 729.53    | 9.44 | 817.56    | 10.58|

According to the result of study in Table 5, by studying 4 types of urban areas: (built-up, green, water, and others), it was found that in 2009 there was a built-up area of 2,421.66 sq.km. (31.34 percent), green area of 4,009.30 sq.km. (51.88 percent), water area of 577.94 sq.km. (7.48 percent), and other areas of 718.43 sq.km. (9.30 percent). In 2014, the urban area increased to 2,712.19 sq.km. (35.10 percent) the green area decreased by 3.76%, the green area decreased by 3,883.68 sq.km. (50.26%), with a 1.62% decrease in the water area 401.93 sq.km. (5.20%), together with a decrease of 2.28% in 2009 and others areas 729.53 (9.44 percent). In 2019, urban areas increased by 3,061.05 sq.km. (39.61 percent), and 4.51 percent increase in 2014. However, considering green areas, it has continued to decline, with areas in 2019 of 3,047.24 sq.km. or 39.43 percent which decreased from 2014 by 10.83 percent. The water area is about 801.47 sq.km. or 10.37 percent, and other areas of 817.56 sq.km. (10.58 percent) as illustrated in Table 5.

In addition, the expansion of housing in Bangkok during 2009 and 2014 can be determined by number of registration of housing which increased steadily with large expansion in term of residential area and the eastern suburbs and agricultural. The condominiums is high proportion in the residential
area and the central business and commercial district, especially in areas influenced by mass rapid transit in the inner Bangkok area. From the statistics between condominiums and housing estates in the period 2009-2014, it demonstrated that the direction of housing selection in Bangkok, are type of condominiums. Therefore, based on number of population and investment in various activities, it indicated the increasing trend of demand for land. Also, the livelihood factors of the urban areas represented the congestion level, together with the government's support for investment in urban infrastructure expansion. This situation lead to the development of the growth in the suburbs due to the ease of access and land prices are at the affordable level. As a result, it demonstrated the change urban pattern in a shift from agricultural communities to urban communities. The use of agricultural land was originally changed to industrial, commercial, and other services.

From the aforementioned evaluation, it can be concluded that during the past, Bangkok has increased land use for urban area development, especially the land use in the area of residential and commercial in the eastern area of Bangkok. However, the expansion of urban areas has resulted in a continued declining in the availability and land use of agricultural land.

4.2 Relationship Between urban areas and Road Patterns

One of the factors affecting the expansion of the city is convenience in traveling with accessibility to the commuting area. Therefore, the analysis of urban growth can be performed. The result of analysis demonstrated the 3 categories of growth into different levels which are low, medium and high as shown in Figure 7.

![Figure 7. Urban growth level of the study area.](image-url)
When considering the pattern of expansion into 3 levels: Low, Medium, and High in 2009, 2014, and 2019, Figure 7 also presented the key evidence of road development in the study area. The urban area and its density of the roads are demonstrated the significant relationship. This is due to the reason that because the density of road networks in urban areas is consistent with urban expansion. It was found that the area with the higher road density, present the higher density of the urban area for circulation. This development patterns also allow people with better access of number of intersections. The result of analysis appealed that urban areas with high urban expansion will have mare road access with more number of intersections as shown in Table 6.

The study of urban expansion patterns and their relationship to transportation infrastructure models is shown in Table 6. The results demonstrated the urban pattern according to the urban expansion levels in three levels: Low, Medium, and High in 2009, 2014, and 2019, respectively. By selecting an area from all three levels to compare the relationship between urbanization and affecting of infrastructure. The urban growth of high level, represented the number of road intersections of 216,330 intersections. The urban growth medium level, there were 28,225 road intersections which is represented an area where infrastructure systems are less develop. Finally, the urban growth low-level presented the minimum of 92,241 points indicated less access to the commuting activities. Urban growth high level is related to road intersections, i.e. 1,136 grid with 216,330 road intersections which is within 1 square kilometer. It was found a large density of the road network which is the central area in Bangkok, accounting for more than 50 percent of the area when analysing the relationship with urban areas found \( R^2 = 0.6244 \). It is found that there is a relationship between the city area and the road network. At the urban growth of medium level, it had the lowest number of grids and road intersections. Since it is an area for urban expansion the city which is gradually expanding, so it is an area that prepares for urban density if the urban infrastructure system is introduced into the area. At the urban growth of low level, there are 6,611 grids of number of road intersections of 92,241 which is less than high level. The relationship between urban areas at all three levels corresponds to the number of infrastructure systems from the value of \( R^2 \) approaching 1, it can be considered the consistent trend in urban expansion and distribution of infrastructure.
Table 6. Road patterns and land use changes in 2009, 2014 and 2019.

| Level of Urban Growth     | Road Intersections (point) | Land use Type | Area (sq.km.) | %      | Area (sq.km.) | %      | Area (sq.km.) | %      |
|---------------------------|----------------------------|---------------|---------------|--------|---------------|--------|---------------|--------|
| Urban Growth High level   |                            | Urban         | 2.55          | 81.33  | 2.63          | 82.51  | 2.73          | 86.89  |
|                           |                            | Green         | 0.19          | 6.00   | 0.32          | 14.54  | 0.37          | 11.77  |
|                           |                            | Water         | 0.00          | 0.00   | 0.00          | 0.00   | 0.01          | 0.31   |
|                           |                            | Others        | 0.40          | 12.67  | 0.09          | 2.95   | 0.03          | 1.02   |
|                           |                            |               | 216,330       |        |               |        |               |        |
| Total                     |                            | Urban         | 1.87          | 59.43  | 1.90          | 60.11  | 1.96          | 62.33  |
|                           |                            | Green         | 0.99          | 31.52  | 1.04          | 32.58  | 1.10          | 34.94  |
|                           |                            | Water         | 0.00          | 0.00   | 0.00          | 0.00   | 0.00          | 0.00   |
|                           |                            | Others        | 0.28          | 9.05   | 0.23          | 7.3    | 0.09          | 2.73   |
|                           |                            |               | 28,225        |        |               |        |               |        |
| Total                     |                            | Urban         | 1.82          | 58.08  | 1.84          | 59.37  | 1.89          | 60.16  |
|                           |                            | Green         | 1.23          | 39.22  | 1.18          | 36.95  | 1.12          | 35.68  |
|                           |                            | Water         | 0.00          | 0.06   | 0.01          | 0.37   | 0.04          | 1.17   |
|                           |                            | Others        | 0.08          | 2.64   | 0.12          | 3.31   | 0.09          | 3.00   |
|                           |                            |               | 92,241        |        |               |        |               |        |
| Total                     |                            | Urban         | 1.82          | 58.08  | 1.84          | 59.37  | 1.89          | 60.16  |
|                           |                            | Green         | 1.23          | 39.22  | 1.18          | 36.95  | 1.12          | 35.68  |
|                           |                            | Water         | 0.00          | 0.06   | 0.01          | 0.37   | 0.04          | 1.17   |
|                           |                            | Others        | 0.08          | 2.64   | 0.12          | 3.31   | 0.09          | 3.00   |
|                           |                            |               | 92,241        |        |               |        |               |        |
| Total                     |                            | Urban         | 1.82          | 58.08  | 1.84          | 59.37  | 1.89          | 60.16  |
|                           |                            | Green         | 1.23          | 39.22  | 1.18          | 36.95  | 1.12          | 35.68  |
|                           |                            | Water         | 0.00          | 0.06   | 0.01          | 0.37   | 0.04          | 1.17   |
|                           |                            | Others        | 0.08          | 2.64   | 0.12          | 3.31   | 0.09          | 3.00   |
|                           |                            |               | 92,241        |        |               |        |               |        |

From the results of analysis, it was found that the more consideration on city expansion was influenced by the more infrastructure allocation and planning. This is to guarantee to meet the needs of the people to have equal access to the city infrastructure by all means, road patterns, and real estate settlements. It was found that the urbanized area have potential for development when roads are connected in a systematic way. The more real estate growth was also found in the area because it indicates level of accessibility which demonstrated a relationship of relatively high land price.

5. Conclusions and Discussion

In an analysis of urban growth affecting changes in land use and urban infrastructure in 2009, 2014, and 2019, the number of road intersections density was utilized as a key indicator to draw a relationship. The 3 levels of urban expansion; low, medium, and high are considered as main categories in the urban expansion analysis. With more roads, more connections, and more intersections, as a result, urban development areas have increased due to the need for convenient access for urban commuting. With a situation of land value effect, the area is quite expensive for the middle class and low-income people. It has been the causing of disparities in housing demand. According to the result of this study, it was found that the city expanded according to the infrastructure system development, comprehensive and accessible infrastructure, in particular, real estate development from the well-known entrepreneurs who
own land and property that benefit from the construction of the infrastructure system in the area. As a result, the areas lead to a higher price consequently spreading the residents to the out-skirt area. Due to the expansion of the city, the cost of living in the city is rather high compared to the average income. As a result, real estate in the suburbs has brought a change to the new housing needs. No longer need for housing development will be located in the city center for low to medium income. Living in the suburbs with better environment with moderate quality transport infrastructure has resulted to super sprawling situation. It is conversely developed by creating a prosperity and infrastructure to achieve a living in a way of balance between urban and suburban areas, providing equal access to government services. Thus, the government must carefully plan to construct transportation system to cover urban and suburban areas by encourage more public transport while alleviate traffic on roads as well as reduce pollution that occurs to promote a society with good quality of life.

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