

Conference Paper

The Influence of Yogyakarta Urban Physical Development to Residential Comfort

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Abstract

The physical development of Yogyakarta urban area took place rapidly. Consequently, the air temperature and humidity in Yogyakarta's urban settlement was changed, and it is impacted to residential comfort. This research aims to study: (i) the physical development of Yogyakarta urban areas; and (ii) the influence of physical development of Yogyakarta urban areas to residential comfort. Yogyakarta urban areas are chosen as research area, based on the rapidly of physical and socio-economic urban development consideration. This research used survey methods by combining of remote sensing image interpretation techniques, field survey, and interview. In each zone selected certain samples as much as 100 respondents that be interviewed. Interview were conducted using a questionnaire. Primary data will be processed with the SPSS software and analyzed by quantitative descriptive and independent sample t-test analysis. This research found out that: (i) physical development of Yogyakarta urban areas is relatively intensive during 2005 until 2015 period; and (ii) it is impacted to residential and environmental comfort. The more developed, the more discomfort.

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1. Introduction

1.1. Background

Yogyakarta is a city that has developed rapidly over time. Yogyakarta city, administratively, has an area of 3 250 ha, but as a consequence of the process of urban aggregation, Yogyakarta urban areas become much more widespread physically (morphologically). The rapid development of Yogyakarta urban areas was triggered by high population growth, either naturally or because of migration and urbanization. This condition causes the Yogyakarta tend to develop into a metropolitan city.

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Yogyakarta urbanites are multi-ethnic and very diverse. This diversity can be found in various formations, traditional and modern, sacred and profane, rich and poor, modern building located at surrounding of traditional building, or vice versa. The surroundings were neat clean, magnificent and attractive, but nearby at dirty and vile neighborhood. Yogyakarta with all cultural diversity illustrates the cultural wealth, artefacts and living culture.

Social diversities and rapid population growth has implications for urban physical development rapidly as well. Physical development is occurred both in inner city (downtown area), which is indicated by building densification and vertical building development, as well as in suburban areas such as urban sprawl. Both of them impacted to increasing of air temperatures in urban areas, which significantly felt mainly by the Yogyakarta urban residents. Currently, there are a variety of environmental issues strongly associated with this phenomenon, for instant, the decrease of green open spaces and degradation of air quality, as a result of the heat island phenomenon.

Settlement is the physical space of human habitation which is equipped with various facilities and where the container and its contents are blended, including people who live in a society in which associated with cultural elements [1, 2]. More specifically, settlements can be articulated by a building that functioned as a residence, or something related to human habitation [3, 4]. In Article 5 of Housing and Settlement Law, Number 4 of 1992, has been stated that every citizen has the right to occupy a decent house in a healthy, safe, harmonious and well organized environment [5]. Therefore, we must pay serious attention to the issue of settlement environment comfort.

In order to identify residential comfort, environmental discomfort index measurement can be used. Generally, environmental discomfort index (or in some literature known as temperature humanity index) is calculated from two aspects, i.e. temperature and humidity. Using the modified Giles equation, the environmental discomfort index can be calculated. The problems to be examined in this study were: (i) how Yogyakarta urban areas are developed physically; and (ii) how the influence of the physical development of Yogyakarta urban areas to residential comfort.

According to Law Number 4 of 1992 Article 1 of the Housing and Settlement mentioned that the definition of settlement stated as follows:

"The settlements are part of the environment outside protected areas, both in urban and rural sphere that serves as a housing area or neighbourhood shelter, and activities that support life and livelihood" [5].

Furthermore, according to Junus [6] the definition of settlement is artificial or natural formations with all its facilities that are used by human, individually or in a groups,

for reside them, either permanently or temporarily, in order to establish their life. Settlements can also be defined as a part of the earth surface inhabited by human, with all its facilities and infrastructure, due to actualize their life in unity [7].

The settlement is basic human needs, complementary to food and clothing. Settlement is a place for human survival and has a significant influence to the health, social behaviour and general welfare in the human community. It also reflects the values of cultural, social and economic of society, as well as the history of civilization in a country [8]. Based on its existence, settlements is divided into urban settlements, rurban settlement and rural settlements [6].

As a human habitation, settlement must be supported by facilities and such a kind of infrastructures [9]. One important aspect of settlement comfort are daily temperature and humidity condition. In order to determine the dwelling comfort, Giles has been established the popular basic equation, so called Discomfort Index (DI). However, the formulation done by Giles is developed for condition of subtropical regions. Unfortunately, Indonesia is not situated in subtropics region, so the Giles formula should be modified.

The quality of dwelling area determines the degree of actual ability of settlement that can be used for shelter [10]. The quality of dwelling area also relate to such a kind of various settlement condition according to the proficiency level of settlers. The degree of human settlements quality involves a man who was in it, the condition of the home building and its surrounding environment.

The settlement quality also depends on environmental variables, i.e. location, physical aspects, psychological and socio-cultural conditions [11]. The Committee on the Hygiene of Housing of the American Public Health Association define the requirements of a healthy settlement is a home that can provide a protection and prevention from hazards to the occupants.

1.2. Research objectives

The purposes of this study are:

- (i) to assess the physical development of Yogyakarta urban areas; and
- (ii) to find out the impact of Yogyakarta urban physical development to residential comfort.

1.3. Research method

The research method is a scientific way to get information with a specific, usefulness purpose, must be logic, empirically, and systematically [12]. The method that used in this research are quantitative and qualitative survey research.

The study area are chosen based on the consideration that physical development of Yogyakarta urban area is very rapid and it can be expected to provide comprehensive results on the real issues of settlements comfort. Data obtained in three ways, namely the interpretation of remote sensing imagery, field work and interviews. Landsat and Quickbird satellite imagery is the main data source of spatial data. Temperature and humidity data are obtained by field work. Due to obtain social economic data, interview was conducted to 100 respondents that is selected by quote sampling.

This research involves two composite variables, they are dependent variables (physical urban development) and independent variables (settlement comfort). The physical urban development variables were analyzed by overlaying time series land use map which are interpreted from remote sensing imagery and processed by GIS software. Settlement's comfort index variables were analyzed using the modified Giles formula.

Based on the premise that Giles formula only implementable for subtropical region, then determination of comfort classification is modified one level as follows:

TABLE 1: Discomfort index (DI) classification [13] with modification.

| Table. | Giles (1990) Yunani | Fandeli (2005) |
|--------------|--|--|
| DI < 21 | Comfortable | Very Comfortable |
| 21 ≤ DI < 24 | < 50 % residents feel uncomfortable | Comfortable |
| 24 ≤ DI < 27 | > 50 % residents feel uncomfortable | < 50 % residents feel uncomfortable |
| 27 ≤ DI < 29 | Mostly residents feel very uncomfortable | > 50 % residents feel uncomfortable |
| 29 ≤ DI < 32 | Very uncomfortable and dangerous | Mostly residents feel very uncomfortable |
| DI ≥ 32 | Harmful to health | Very uncomfortable and dangerous |

The equation for calculating the comfort index according to Giles et al. [14] are as follows:

$$DI = T_a - 0.55 (1 - 0.01RH) (T_a - 14.5) \tag{1}$$

DI: Discomfort Index

T_a : Dry ball temperature (°C)

RH: Relative Humidity (%)

To validate the comfort index data, the interviews techniques are done. 100 dwellers are chosen as respondents. The data have been processed and analyzed by statistical data analysis tools, they are quantitative descriptive analysis and t-test. The results are presented in tables, graphs, charts and thematic maps.

Limitation

- Healthy settlement is a home that can provide a protection and prevention from hazards to the occupants [15]
- Physical urban development is the development process that occurred in inner city (downtown area) and its surrounding, which is indicated by building densification and vertical building development [11]
- Settlement is the physical space of human habitation which is equipped with various facilities and where the container and its contents are blended, including people who live in a society in which associated with cultural elements [1]
- Residential comfort is the condition of temperature and humidity in the settlement area.

2. Physical Development of Yogyakarta Urban Areas

Evolution of social, cultural, demographic and administrative boundaries of Yogyakarta in the past has caused the dynamics of its urban morphology. The urban morphological development occurs continuously over time through a process of urban land use annexation into non-urban areas beyond the city administrative boundary. Based on the interpretation of satellite imagery data, total area of the urban built up of Yogyakarta is 15 197.2 ha in 2010 and 15 571.2 ha in 2015. It means that total areas of Yogyakarta urban areas are 370 % (in 2010) and 382 % (2015) of the total area of Yogyakarta city (administratively), which is an area of 3 250 ha.

The addition of the Yogyakarta urban land use during 2005 to 2010 was 1 801 ha, covering 50 ha in the inner city and 1 751 ha in the suburbs (Table 2). The expansion of the urban area is dominated by leapfrog development type and spatially occurred

in southern zone (southeast, south, and south west part). South-east zone is an area that experienced the largest expansion.

In general, developments in 2005 to 2010 period showed a trend as a process of sub-urbanisation or peri-urbanisation. It is indicated by development of urban functions dominant in suburban and periurban areas is very dominant. Commercial and services areas that are spatially associated with new urbanity settlements mushroomed on the outskirts of the city. Factors that trigger this phenomenon are the better road infrastructure that linking the suburbs to the city centre and supported by the affordability of private motor vehicles ownership.

The changes of Yogyakarta urban areas during 2010 to 2015 shows the tendency of decreasing compared to the 2005 to 2010 period (Table 2). Table 2 shows that the percentage of the urban land use in outer city has increased, while the percentage of the urban land area in inner city has decreased. This condition indicates that the attractiveness of inner city have a tendency to become weaker, while the appeal of outer city is increasing. Table 2 also showed the process of comprehensive development of urban areas. During 2005 to 2015, the urban development in the inner city occurred relatively constant and ramps, while in the suburbs increased more intensively. It can be concluded that the increase of total area of Yogyakarta urban areas is determined by the increase of urban land use in the suburbs.

TABLE 2: Yogyakarta Urban Built Up Areas Year 2005 to 2015.

| Year | Inner City | % UBUA | % CA | Outer City | % UBUA | % CA | Total Built Up Areas | City Area |
|--|------------|--------|------|------------|--------|-------|----------------------|-----------|
| 2005 | 3 095.58 | 23.1 | 95.2 | 10 300.80 | 76.9 | 316.9 | 13 396.378 | 3 250 |
| 2010 | 3 145.40 | 20.7 | 96.8 | 12 051.72 | 79.3 | 370.8 | 15 197.117 | 3 250 |
| 2015 | 3 154.22 | 20.3 | 97.1 | 12 416.99 | 79.7 | 382.1 | 15 571.212 | 3 250 |
| % UBUA = Percentage by Urban Built Up Area | | | | | | | | |
| % CA = Percentage by Yogyakarta City Area | | | | | | | | |
| Unit area = ha | | | | | | | | |

Fig. 1 is a map that is illustrated the change of Yogyakarta urban areas during 2005 to 2010. It shows spatial dynamics of the urban sprawling process in the study area. The map is produced by overlaying time series land use maps. Overall, the accretion of urban built up areas in each zone indicate a bit uneven intensity. The intensity is relatively low in the inner city, while in the northern part (Sleman) is relatively high, and in the south part (Bantul) as well.

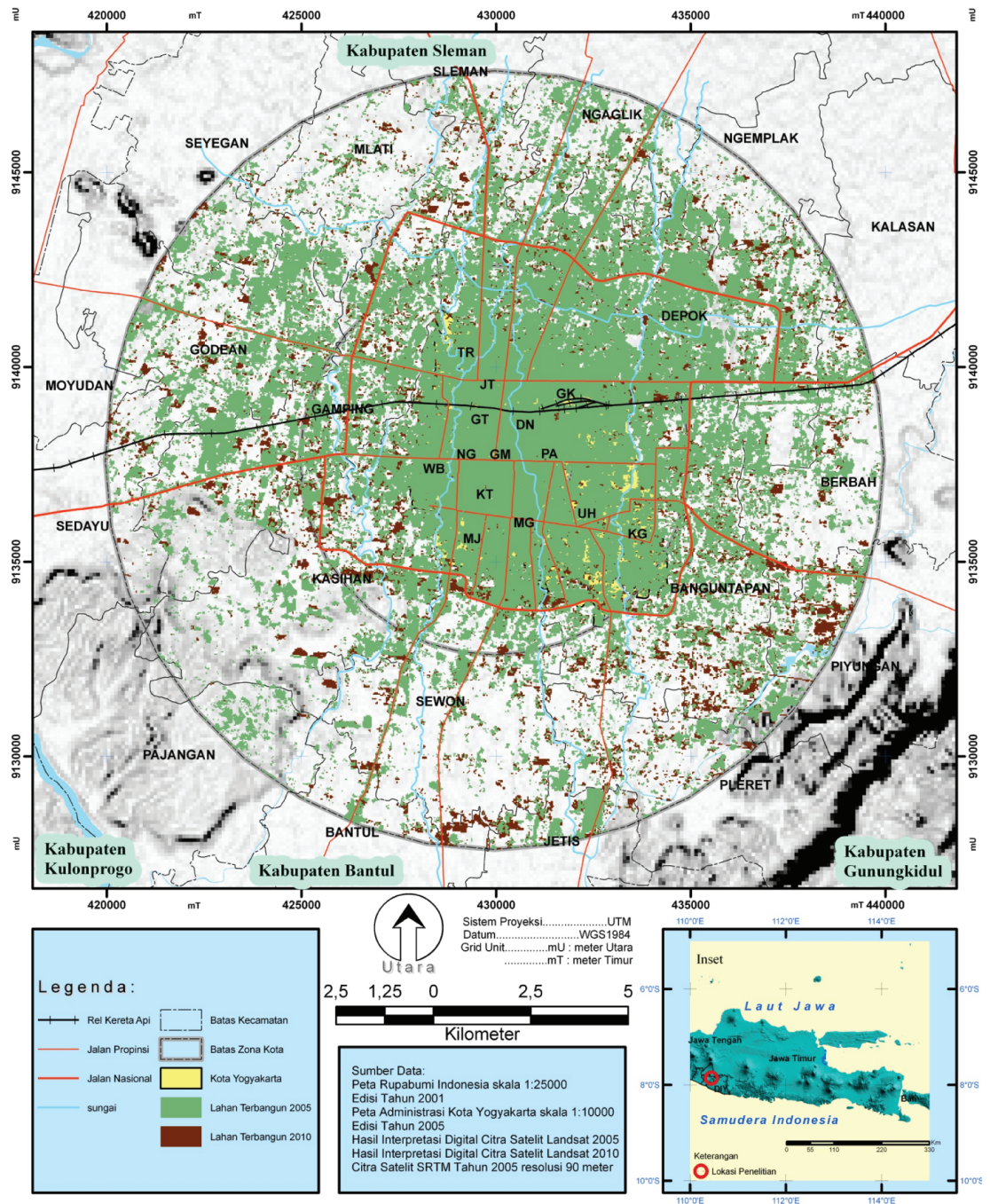


Figure 1: Yogyakarta Urban Built up Areas Changes Map during 2010 until 2015.

3. The Influence of Yogyakarta Urban Physical Development to Residential Comfort

Based on the results of field measurements during the late morning (around 10 am), the air temperature in the inner city of Yogyakarta ranges between 29 °C to 32 °C, while in the Sleman suburban area is ranging between 30 °C to 35 °C and in the Bantul suburban

areas between 28 °C to 34 °C. The air temperature in inner city tend to be lower than in the suburbs. Associated with the humidity conditions in each zone, the people who live in the inner city of Yogyakarta said that the air humidity become fresher (53 % of respondents), while people who live in Sleman region are mostly felt more chills (39 %) and people who live in Bantul region mostly felt no difference (48 %), comparing to the last decade (see Table 3).

This fact indicates that the humidity conditions in the inner city has not change significantly, while in the suburbs experiencing significant change perceived by the majority of the settlement inhabitants. The changes of humidity condition are more affected to people who live in the suburbs. The significant change of humidity condition in the suburbs is caused by the compaction of the building in that location are much more intensive (see Table 4).

Table 3 shows that the respondents who live in the Yogyakarta inner city, mostly, stated that building additions were relatively small (51 % of respondents), while in Sleman region mostly expressed that compaction of the building is high (56 % of respondents), whereas in Bantul regency also stated that compaction is high (47 %). This indicates that the building densification process in the suburbs are more intensive, and it is impact to the residents perceived higher swelter condition significantly.

TABLE 3: Air Condition Changes (swelter) in each region.

| | | Air Condition Changes (swelter) | | | Total |
|--------|-----------------|---------------------------------|-------------|-----------|-------------|
| | | More Chills | Nearly same | Fresher | |
| Region | Yogyakarta City | 7 | 14 | 24 | 45 |
| | | 15.6 % | 31.1 % | 53.3 % | 100.0 % |
| | Sleman | 9 | 8 | 6 | 23 |
| | | 39.1 % | 34.8 % | 26.1 % | 100.0 % |
| | Bantul | 4 | 18 | 15 | 37 |
| | | 10.8 % | 48.6 % | 40.5 % | 100.0 % |
| Total | | 20 19.0 % | 40 38.1 % | 45 42.9 % | 105 100.0 % |

Besides the factor of building densification horizontally, the swelter condition also influenced by vertical building densification that characterized by the addition of the number of the floor. Table 5 shows the data concerning the addition of number of the building floors in Yogyakarta city and in the suburbs. The fact shows that it is similar with the phenomenon of building densification horizontally. Majority, respondents who

TABLE 4: Building Densification in each Region.

| | | Building Densification | | | Total |
|--------|-----------------|------------------------|--------------------|---------------|---------|
| | | Excesively Densified | Slightly Densified | Not Densified | |
| Region | Yogyakarta City | 10 | 12 | 23 | 45 |
| | | 22.2 % | 26.7 % | 51.1 % | 100.0 % |
| | Sleman | 13 | 10 | 0 | 23 |
| | | 56.5 % | 43.5 % | 0 % | 100.0 % |
| | Bantul | 17 | 18 | 2 | 37 |
| | | 45.9 % | 48.6 % | 5.4 % | 100.0 % |
| Total | | 40 | 40 | 25 | 105 |
| | | 38.1 % | 38.1 % | 23.8 % | 100.0 % |

live in the inner city of Yogyakarta states that in their location, there are no additional number of building floor (44 %), whereas in Sleman region, mostly, respondents stated that there are intensively additional number of house building floor (39 %) and in Bantul region likewise (40 % of respondents) (see also Table 5).

TABLE 5: Additional Number of Floor of House Building in each Region.

| | | Additional Number of Floor | | | Total |
|--------|-----------------|----------------------------|----------------|-----------|---------|
| | | Excesively Added | Slightly Added | Not Added | |
| Region | Yogyakarta City | 14 | 11 | 20 | 45 |
| | | 31.1 % | 24.4 % | 44.4 % | 100.0 % |
| | Sleman | 9 | 8 | 6 | 23 |
| | | 39.1 % | 34.8 % | 26.1 % | 100.0 % |
| | Bantul | 15 | 9 | 13 | 37 |
| | | 40.5 % | 24.3 % | 35.1 % | 100.0 % |
| Total | | 38 | 28 | 39 | 105 |
| | | 36.2 % | 26.7 % | 37.1 % | 100.0 % |

Based on these facts, most citizens of the Yogyakarta inner city perceived that environmental comfort during the last 10 yr is relatively unchanged (38 % of respondents). Contrary with this situation, the perception of dwellers who live in Sleman region

mostly feel that the environment is getting worse (48 % of respondents) and in Bantul region as well (38 %) (see Table 6).

TABLE 6: Perception of Residential Environment Comfort in each Region.

| | | Perception of Residential Environment Comfort | | | Total |
|--------|-----------------|---|-----------|--------|---------|
| | | Better | Unchanged | Worse | |
| Region | Yogyakarta City | 12 | 17 | 16 | 45 |
| | | 26.7 % | 37.8 % | 35.6 % | 100.0 % |
| | Sleman | 5 | 7 | 11 | 23 |
| | | 21.7 % | 30.4 % | 47.8 % | 100.0 % |
| | Bantul | 10 | 13 | 14 | 37 |
| | | 27.0 % | 35.1 % | 37.8 % | 100.0 % |
| Total | | 27 | 37 | 41 | 105 |
| | | 25.7 % | 35.2 % | 39.1 % | 100.0 % |

To determine whether the analysis mentioned above is in accordance with real conditions on the field, then correlation analysis is conducted. Table 7 is a crosstab which presents the correlation analysis between housing densification with the perception of house building comfort. It indicated that respondents who experienced intensive building densification in their settlement lots, they perceived that their residential environment are worse (64 % of respondents). Most respondents who is experiencing with slightly building densification, they perceived that the residential comfort is nearly same (50 % of respondents). And viceversa, respondents who perceived that their dwelling environment are better, they experiencing with no building densification in their surrounding (48 % of respondents). It is accordance with the statement has been described in the previous section.

Table 8 shows the correlation between additional number of building floor and the perception of residential comfort. It was found out that most respondents who live in stagnant condition according to number of building floor, they perceived that the residential comfort are better (39 % of respondents), as well as dwellers who live in the settlement which slightly additional number of building floor (42 % of respondents). Whereas, respondents who live in an excessive additional storey building, they perceived that residential comfort is become worse (65 %) (see Table 8).

The relationship between the air condition and the perception of environmental comfort is shown in Table 9. It is found out that the majority of respondents who

TABLE 7: Correlation between Comfortability Perception and Building Densification.

| | | Building Densification | | | Total |
|---|-------------|------------------------|--------------------|---------------|---------|
| | | Excesively Densified | Slightly Densified | Not Densified | |
| Perception of Settlement Environment Comfortability | Better | 3 | 13 | 15 | 31 |
| | | 9.7 % | 41.9 % | 48.4 % | 100.0 % |
| | Nearly Same | 13 | 20 | 7 | 40 |
| | | 32.5 % | 50.0 % | 17.5 % | 100.0 % |
| | Worse | 22 | 10 | 2 | 34 |
| | | 64.7 % | 29.4 % | 5.9 % | 100.0 % |
| Total | | 38 | 43 | 24 | 105 |
| | | 36.2 % | 41.0 % | 22.8 % | 100.0 % |

TABLE 8: Correlation between Perception of Residential Environment Comfort and The Additional Number of Building Floor.

| | | Additional Number of Building Floor | | | Total |
|--|-------------|-------------------------------------|----------------|-----------|---------|
| | | Excesively Added | Slightly Added | Not Added | |
| Perception of Residential Environment Comfortability | Better | 10 | 9 | 12 | 31 |
| | | 32.3 % | 29.0 % | 38.7 % | 100.0 % |
| | Nearly Same | 10 | 13 | 17 | 40 |
| | | 25.0 % | 32.5 % | 42.5 % | 100.0 % |
| | Worse | 18 | 6 | 10 | 34 |
| | | 52.9 % | 17.6 % | 29.4 % | 100.0 % |
| Total | | 38 | 28 | 39 | 105 |
| | | 36.2 % | 26.7 % | 37.1 % | 100.0 % |

feel much more swelter, they perceived that their environmental comfort are become worse in the last 10 yr (62 % of respondents). In other hand, respondents who feel that there is no significant air condition changes, they perceived that their environmental comfort are quite same (43 % of respondents). Respondents who felt that

the air conditions is better, they perceived that the environmental comfort also better (55 % of respondents). This fact is in line with previous analysis as is mentioned before.

TABLE 9: Correlation between Perception of Residential Environment Comfort and Air Condition Changes.

| | | Air Condition Changes (swelter) | | | Total |
|---|-------------|---------------------------------|------------|-------------|---------|
| | | Better | Quite Same | More Chills | |
| Perception of Settlement Environment Comfortability | Better | 17 | 7 | 7 | 31 |
| | | 54.8 % | 22.6 % | 22.6 % | 100.0 % |
| | Nearly Same | 6 | 17 | 17 | 40 |
| | | 15.0 % | 42.5 % | 42.5 % | 100.0 % |
| | Worse | 7 | 6 | 21 | 34 |
| | | 20.6 % | 17.6 % | 61.8 % | 100.0 % |
| Total | | 30 | 30 | 45 | 105 |
| | | 28,6.0 % | 28.6 % | 42.8 % | 100.0 % |

4. Conclusions

Based on the results of this study can be drawn two conclusions:

- (i) Physical development of Yogyakarta urban areas occurred rapidly in the last 10 yr (2005 to 2015), were marked by the increasing number urban built up areas, especially in the suburbs.
- (ii) The physical development of Yogyakarta urban influenced on the change of residential comfort. The more intensive physical development, especially those occurring in the suburbs, the more degraded residential comfort.

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