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UNDERSTANDING THE CONSEQUENCES OF A CITY'S SPATIAL STRUCTURE THROUGH ITS DENSITY PROFILE AS INDICATOR. A CASE STUDY IN MANADO MUNICIPAL, NORTH SULAWESI, INDONESIA

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ABSTRACT

This paper aims to identify the spatial structure of Manado municipal, capital of North Sulawesi Province in Indonesia, through its density profile as indicator, which is the trend of density level according to the spatial units distance to the city center. This paper also tries to elaborate on the potential problems in the city as well as the urban planning policy which are associated with the spatial structure identified. The data used are the maps of administrative and built-up area and the distribution of population and service center by spatial units in Manado. The parameters of density profile examined are the administrative and built up density and the accessibility distance to the city center from the service center of the spatial units. By interpreting the existing density profile based on some relevant theoretical premises, the spatial structure type and its associative problems and policy can be identified. The result shows that the spatial structure of Manado municipal tends to be monocentric in certain boundary from the city center, but start shifting to polycentric pattern in the peri-urban zone. This characteristic is associated with some potential problems such as acute traffic congestion, air pollution, emerging of slum and squatter and the increased risk of disasters, specifically on downtown area. In the peri-urban zone, the potential significant problems is the phenomenon of sprawling and all its associated impacts such as fragmentation of green open space, increased dependence on private vehicles and increased investment and maintenance costs for infrastructure.

INTRODUCTION

Importance of Urban Spatial Structure The spatial structure of a city is a complex and unique aspect as a result of long-term interactions between land market, landscapes, regulations and taxation policies. The spatial structure of a city is constantly developing. Often, the application of land use policies and infrastructure investments in a city actually creates a counterproductive effect because it is not developed based on a clear understanding of the existing spatial structure. It is very important for the authorities to always monitor the development of local spatial structure so that they can form anticipatory policies when the existing trends are not in accordance with the vision of the city's development in the future (Bertaud & Malpezzi, 2003;). Concept of Urban Density as Basis of Understanding the Spatial Structure Spatial structures and the spatial distribution of urban populations do interact. The population's structure plays a key role in realizing a rational urban spatial structure, which impacts a city's sustainable development, that in turn forms the basis and premise of scientific spatial planning (Gao et al, 2018). The concept of urban density has developed long enough in the context of understanding the spatial structure of a city, but still has important value for improving the quality of urban planning and design, as well as in scientific research activities.

Today, a good approach is the one which able to show the interrelation between two aspects of density namely "built density and activity density" (Krehl et al, 2016; Berghauser Pont & Haupt, 2009). A certain study shows that the spatial structure of a city can be identified through two aspects of density, namely the spatial distribution of the population according to census data of their living place (static density or density by night) and the daily pattern of population travel within the city (dynamic density or density by day). In particular, the first component can be further identified through two indicators, namely the average built-up density and the density profile. The density profile is an indicator that shows the relation between the level of land density built by a spatial unit in a city and the distance of the spatial unit to the city service center. This indicator is usually displayed in the form of graphs of paired data (Wu & Webster, 2019; Bertaud, 2001). Types of Urban Spatial Structure and the Associated Problems & Solutions In the traditional view, there is a dichotomy that a city if not has monocentric structure (a single service center) must inevitably have a polycentric structure (multiple service centers). In reality no city has a purely monocentric or polycentric structure. Each city can only be described as having a "tendency" to have a monocentric or polycentric structure. One important understanding is that a monocentric city is the one that tend to have a high average density with low density dispersion, an ideal condition in the concept of urban compactness. In contrast, the city of polycentric is associated with a city that has a low average density with high density dispersion, which is also associative with urban sprawling phenomena (Bertaud, 2004). The degree of monocentricity or polycentricity of a city is basically associated with the type of problems and specific solutions. In particular, monocentricity or polycentricity of a city will associate with the travel behaviour patterns of city residents (Koncheva & Zalesskiy, 2016; Ewing & Cervero, 2010; Forsyth, 2003). A monocentric city is incompatible with a transportation system that relies on private vehicles or small-scale public transport because of the high risk of causing congestion, and is more suitable to prioritize the concept of urban walkability. In contrast, polycentric city is not compatible with infrastructure systems and mass public transportation due to long travel distances and large infrastructure investments (Bertaud & Richardson, 2004). In a polycentric city with a longer travel distance, the level of carbon emissions of motor vehicles will be higher but not concentrated. In contrast to monocentric cities, even though the level of carbon emissions is relatively low (due to relatively short travel distances), the air pollution is more concentrated because the active built up area is relatively small. Thus, the threat of carbon emission of motorized vehicles tends to be more significant in monocentric cities than in polycentric cities, (Wu et al., 2016; Bertaud, 2002;). A study shows that the more compact the city, the less conducive it is to improve CO2 emission efficiency. Polycentric city is better in improving the CO2 emission efficiency (Sha et al, 2020). However, a particular study shows that some polycentric urban structure do not achieve the effect of carbon emission reduction to a certain extent (Wang et al, 2022). These notion is inline with the findings of other study that shows monocentric spatial structure has higher environmental efficiency than the polycentric spatial structure, unless the population density is beyond 280 persons/km2 (Ye et al, 2022). Some researchs show that monocentric structure can produce agglomeration effects (Yuan et al., 2018; Han et al., 2020), and also improves resource efficiency and reducing environmental pollution (Tao et al., 2019; Zhao et al., 2019). A city with a monocentric structure is seen as having several advantages. Some studies show that along with the increasing built up density of a city, the number of trips by walking, cycling and public transportation also increases, related to short travel distances (Brownstone & Golob, 2009; Ewing & Rong, 2008). Some studies in economics also show that high density allows the exchange of ideas and knowledge between individuals, groups of people and even

businesses, so as to create opportunities for greater success. This premise supports the argumentation why various business services that depend on proximity are commonly found in high density areas and surroundings (Krehl, 2015; Duranton & Puga, 2005). Another premise suggests that the cost of provision of infrastructure tends to decrease when density increases (Burchell & Mukherji, 2003). In addition to the excellences, the high density of a city is also associated with a number of potential problems, including the tendency of high levels of property prices and congestion problems in the transportation system (Melo et al., 2016; Duranton & Puga, 2005), low air quality and uncomfortable microclimatic conditions, threat of carbon emission of motorized vehicles (Wu et al., 2016; Watkins et al., 2007; Bertaud, 2002), also associate with increasing population vulnerability to a variety of hazard threats including the risk of disease outbreaks (McFarlane, 2015; Patel et al., 2009; Koppe et al., 2004). In contrast, the polycentric city is commonly associated with the urban sprawling phenomena. Some disadvantages of sprawl are infrastructure costs, conversion of valuable agricultural land, and deterioration of environmentally sensitive areas. In positive perspective, sprawl is commonly linked with suburbanization of economic activities, which is the decentralization of activities from the central core to the urban periphery (Divigalpitiya & Handayani, 2015). In economics viewpoint, in low density cities, even though the average property prices tend to be 'low' the opportunity for the existence of business services is less prospective if present independently, unless the existence is clustered at the local service centers. The low property prices is more an attraction for the growth of the industrial sector (other than housing) which requires relatively large plots of land but with low costs. Efforts to 'search' cheap property fields in turn will encourage the sprawling phenomenon with 'leapfrog', 'ribbon' and 'scattered' patterns, so that the structure and shape of cities in peri-urban areas is increasingly towards a condition called 'endless city' (Angel et al., 2007). In cities with low densities the level of risk to hazard threats tends to decrease due to the low potential for population exposure to hazard (McFarlane, 2015; Patel et al., 2009; Koppe et al, 2004). Certain study states that in the context of metropolis area, polycentric structure is more preferred. In this study the metropolis area is recommended to establish new urban areas for forming a multi-centre structure, which can disperse population and reduce population density. This policy must be accompanied by the effort to renovate the old town (city center) and to rationally change the industrial layout and guide industrial migration out of the old town. This policy also demand the improvement of the traffic infrastructure to reduce the commuting time of migrant workers living on the periphery of the city (Gao et al, 2018). Background and Purpose of the Study The physical growth of the Manado municipal which is relatively fast in the last few decades basically raises a variety of problems that need to be anticipated. Traffic congestion and the impact of disasters (especially floods) are some problematic issues which are logical consequences of the city's physical growth. Since 2014, the city of Manado has enacted the local regulation concerning the city's spatial plan which is valid until 2034. Every five years this plan needs to be reviewed and adjusted. In 2023, the urgency to review the plan has become so important and needs to be done by utilizing all information regarding the latest developments in this city. One of the substances in this spatial plan is the plan of the city's spatial structure related to the strategic policy of structuring the distribution of population as well as the service centers and infrastructure systems. A good urban spatial structure plan should be prepared based on an understanding of the existing spatial structure type which is related to the pattern of the population density distribution of the city concerned. This insight will enable the local authorities to identify the associated problems and decide the better spatial structure plan for the city. Referring to the theoretical understanding above, the spatial structure of a city can be identified through a number of indicators related to population density, one of which is the

density profile. By studying the indicators, the characteristics of the spatial structure of a city and its evolution in the future can be understood carefully and can be the basis of arguments in the formulation of the city's spatial planning policies, especially the hierarchical distribution of city service centers in a manner and the infrastructure network development. Based on the above points of thought, a complete understanding of the spatial structure of the Manado municipal through population density profile as indicator is an urgent matter, especially if it is associated with the need for a review of the city's spatial plan which. This paper in particular focuses on two substantial questions. At first, this paper tries to answer the question concerning how is the existing pattern of the spatial structure of Manado municipal if assessed based on density profile as the indicator. Secondly, this article also wants to identify what are the potential anticipated problems and what are the options of spatial policy which are compatible regarding the pattern of existing spatial structure of Manado municipal. The answer to these questions will be elaborated further in the discussion section of this paper.

RESEARCH METHOD

To construct the pattern of density profile of the city, the data needed and collected in this study include: 1) map of the administrative boundaries of the city, based on the administrative level of the district and sub-district, 2) map of the built-up area of the city, 3) population of the city, described by district and sub-district spatial units, 4) map of urban service centers in a hierarchical manner starting from primary service centers to the level of the service center of the sub-district spatial units. The 1st to the 3rd data above are basically secondary data collected through institutional survey / visit to some bureaus of the local government. The 4th data is obtained by conducting field observations to see the tendency of public facilities concentration in each district / sub-district level. There are basically two stages of analyses in this study. The first one is the construction of the density profile pattern. In this stage of analysis there are three steps of methodology. The first step is the quantification and the mapping of population density distribution in the city by its spatial units (districts and sub-districts). This step utilizes the availability of the 1st to 3rd data described above. In simple math, the density of each spatial unit is calculated in two parameters which are the administrative density and the built up density.

The administrative density is obtained by dividing the population number with the administrative area of each spatial unit. In the same logic, the built up density is derived from the dividing of the population with the built up area of each spatial unit. Both parameters are in person per hectare (Pr/Ha). The result are then presented in form of table and map of population density distribution. The second step is the measuring of the proximate accessibility distance of local district / sub-districts service centers from and to the primary city service center. This step uses the 4th data described above. This proxy distance parameter is in kilometer (km). The third step is to correspond the results of the previous two steps in form of a table of paired data. The correspondence of the two results forms a pattern of density profile in the city, which shows the trend of decreasing or increasing density according to the distance of the local spatial unit service center from and to the city service center.

The second stage of analysis is the interpretation of the existing density profile concerning the type of spatial structure of the city and its associated problems and compatible policy. This stage includes two interpretation steps. The first one is the interpretation of the spatial structure typology. In this step information on the density profile of the city of Manado are reviewed to see whether the spatial structure of the city of Manado tends to be monocentric or polycentric. The second step of this stage is to interpret the variety of potential problems and

options of spatial policies that are associative with the spatial structure of the city. These interpretation is carried out by considering the relevant theoretical premises that have been stated previously.

RESULTS AND DISCUSSION

Density Distribution in Manado

Manado is the capital of North Sulawesi Province in the Republic of Indonesia. The administrative area of Manado municipal covers 11 (eleven) districts (Bunaken, Bunaken Islands, Malalayang, Mapanget, Paal Dua, Sario, Singkil, Tikala, Tuminting, Wanea and Wenang), each with a number of sub-districts totalling 87 units of kelurahan. Based on the results of digitizing the boundary maps, the administrative area of the city is 15,858.16 ha. The district with the largest administrative area is Mapanget and the smallest is Sario. In the level of sub-district, the largest administrative area is in Bengkol (district of Mapanget) and the smallest is in Komo Luar (district of Wenang).

The built up area data was obtained by digitizing the built up area identified through the satellite imagery of the city provided by the local authoritative. The results show that the total area of built up area in the city had reached 5,406.84 ha or about 34% of the total administrative area. The highest percentage of built up area is in the district of Sario (98.75%) and the smallest is in the district of Bunaken Islands (6.07%). In the level of subdistrict, the highest percentage of built up area and reaching 100% was identified in several sub-district in the district of Wenang, Sario (at most), Singkil, Tuminting and Wanea. Figure 1 below shows the maps of administrative area and built up area of the city.

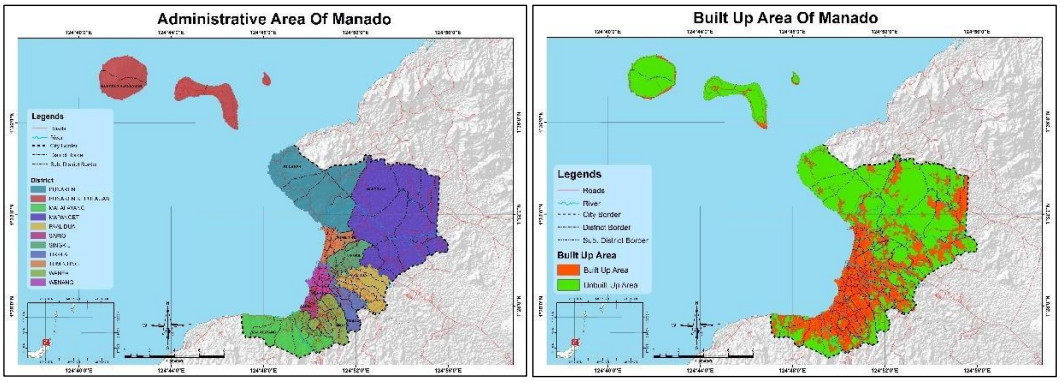

Figure 1. Map of Administrative Area & Built Up Area of Manado Municipal

Referring to the Manado Central Bureau of Statistics publication, the population of this city as a whole is 412,746 people. The district with largest population is Malalayang and the smallest is Bunaken Islands. In sub-district level, the largest population is in Teling Atas (Wanea) and the smallest in Alung Banua (Bunaken Islands). The density distribution in Manado can be described into two parameters which are the administrative density and the built up density. By utilizing the data obtained, the density distribution of Manado municipal, based on the district and sub district area, are then calculated and presented in form of maps in Figure 2 and 3 below

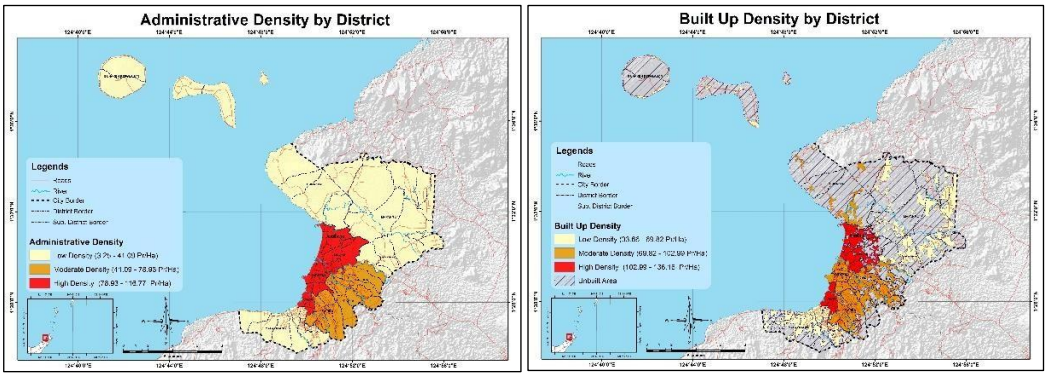

Figure 2. Map of Administrative & Built Up Density Distribution Based on District in Manado

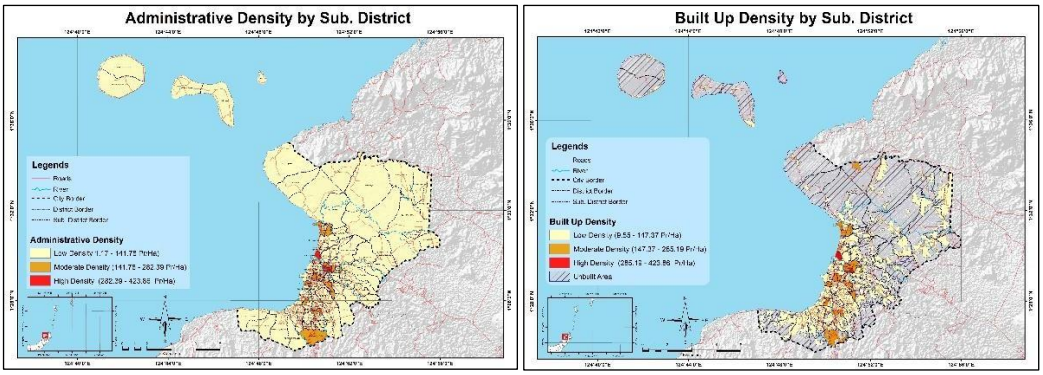

Figure 3. Map of Administrative & Built Up Density Distribution Based on Sub-District in Manado

Service Centers Distribution in Manado

The map of service centers distribution shows that the district service center farthest from the city center is Bunaken Islands (14.17 km) and the closest is Wenang (0.00 km). The farthest service center at the sub-district level is Manado Tua I (24.35 km) and the closest is Wenang Utara (0.11 km). Figure 4 below shows the map of service center distribution in Manado.

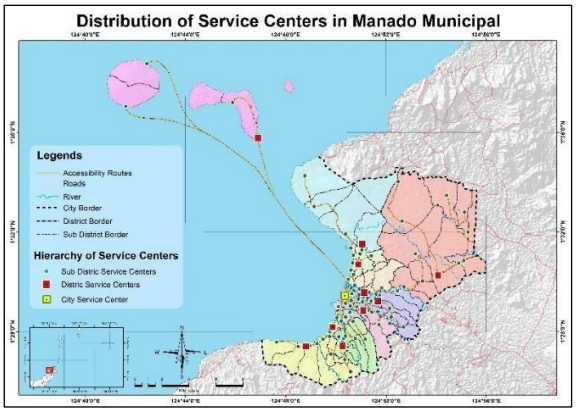

Figure 4. Map of Service Center Distribution in Manado

Density Profile in Manado Based on District

By utilizing the paired data of administrative and built up density with the proximate distance of service centers to the city center for each district, the density profile of the city of Manado can be presented in the form of a scatter plot diagram in the Figure 5 below, suplemented with trendline and regression equation.

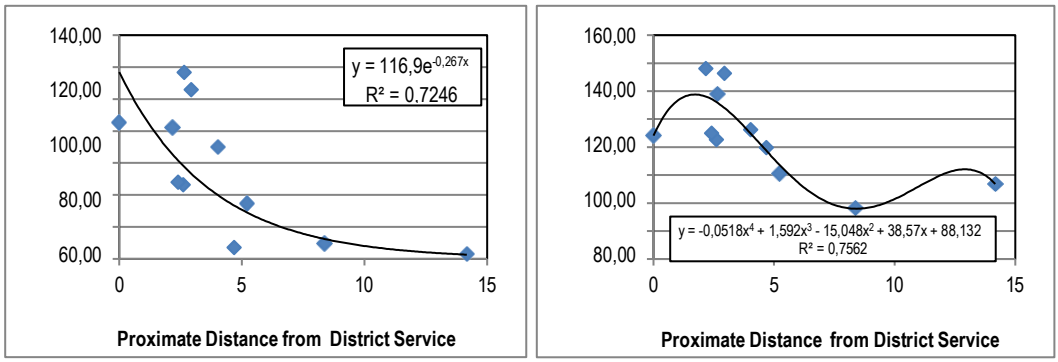

Figure 5. Scatter Plot of Relation Between Proxy Distance of Accessibility and Density Parameters (Administrative & Built Up Density) Per District in Manado

From the graph, it can be seen that at the district level the relation between the proxy distance of accessibility and the administrative density shows a relatively high determination coefficient (R2 = 0.72), where the administrative density per district tends to decrease exponentially along with the increasing distance from the district service center to the city center. It also shows that the relation between the distance of the service center to the city center and the built up density shows a relatively high determination coefficients (R2 = 0.76), where the density of built-up land per district tends to decrease polynomially. along with the increasing distance from the district service center to the city center. In details, there is an anomaly of relatively high densities at the peri-urban services center occur in the Bunaken Islands district.

Density Profile in Manado Based on Sub-District

Density profile of the city is also traced based on sub-district spatial units. By utilizing the paired data of administrative and built up density with the proximate distance of service centers to the city center for each sub-district, the density profile of the city of Manado can be presented in the form of a scatter plot diagram in the Figure 6 below, suplemented with trendline and regression equation.

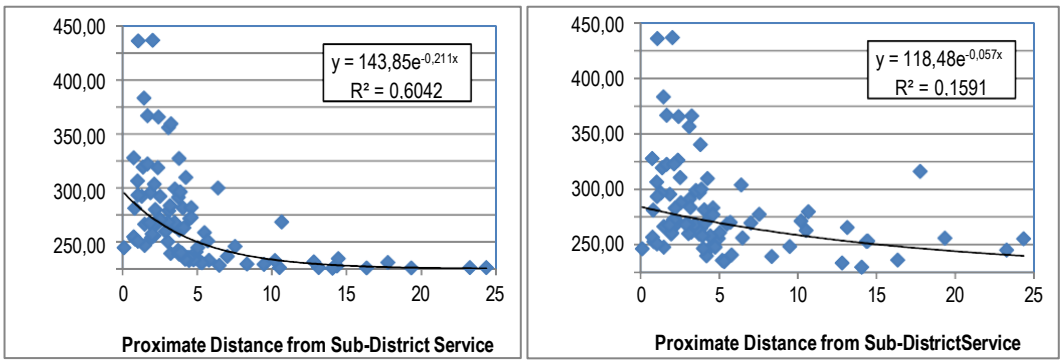

Figure 6. Scatter Plot of Relation Between Proxy Distance of Accessibility and Density Parameters (Administrative & Built Up Density) Per Sub-District in Manado

From this figure, it can be seen that the relation between the distance from the sub-district service center to the city center and the administrative density shows a pattern where the coefficient of determination is relatively moderate (R2 = 0.60), where the administrative density per sub-district tends to decrease exponentially as the distance increases. It can be seen also that at sub-district level the relation shows a relatively low coefficient of determination (R2 = 0.16). With this condition it can be said that basically there is no significant relationship between the two observed variables. However, it can be seen from the dispersion of data points there are indications that the built up density tends to be higher in the sub-districts whose service centers are close to the city center and vice versa.

Manado Spatial Structure based on Density Profile

Referring to the conditions above, the typical tendency of Manado's spatial structure based on density profile can be stated in the following points of thought. The existence of district service centers has a stronger determination to the density conditions than the existence of sub-district service centers. The development of the district service centers will determine the growth of population and built-up area in a district. The trend of decreasing density level as the increase in distance of local service centers from the city center is an indication of the occurrence of the sprawling phenomenon in Manado. This also shows that the quality of compactness of the spatial structure of the city tends to decrease in the peri-urban zone. This trend is a common attribute of sprawl manifestation. Referring to the national standard (Anonymous, 2004), at the district level, the density of Manado (built up density in particular) is still categorized as low (200 pr/ha). This condition shows that the level of compactness or the monocentric tendency of the spatial structure of the city is only significant at a radius of distance <5 km from the city center (zero point). Outside this boundary, the spatial structure of the city tends to shift to a polycentric characteristic (relatively low density level of spatial units with increasing sprawling phenomena).

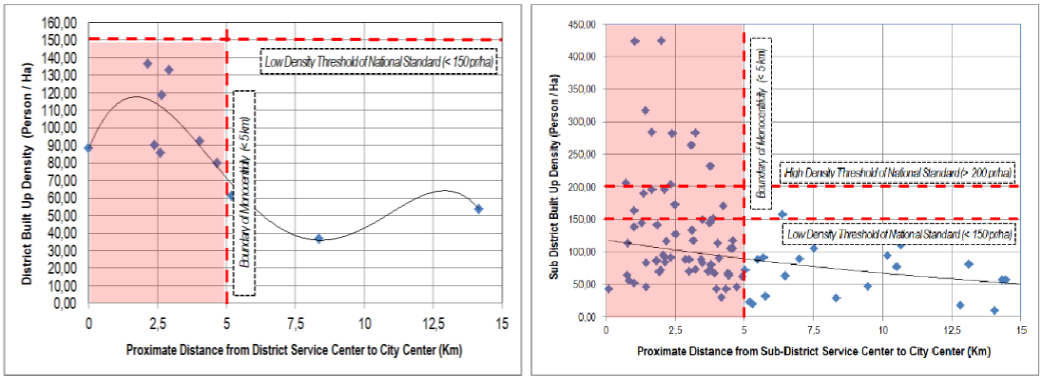

Figure 7. Indication of Monocentricity Boundary of Manado's Spatial Structure Through Built Up Density Profile Graphics

Context of Problems and Spatial Policy Options Related to the Type of Spatial Structure of Manado Municipal

The Associated Problems

The tendency of the spatial structure of the city of Manado as stated above can basically be the information that needs to be considered in forecasting the consequences of potential

urban problems. Departing from the existing theoretical premises, the city of Manado, with the spatial structure as previously identified, is faced with a number of problems which can be described as follows. In area around the city service center (zero point), within a radius of <5 km, especially the districts of Wenang, Singkil, Tuminting, Sario, Wanea, Tikala and Paal Dua with relatively high levels of built up density, excessive use of personal vehicles as mode of transportation will put high pressure on the carrying capacity of the existing infrastructure so that the phenomenon of congestion will be increasingly acute (Bertaud & Richardson, 2004). The high level of traffic congestion will trigger a high but inefficient level of energy consumption along with the risk of increasing concentration of carbon emissions which reduces air quality and local microclimatic conditions which further adds to environmental discomfort (Jianxin Wu et al., 2016; Watkins et al., 2007; Bertaud, 2002).

In the same segment, economically, the strategic value of the region will increase and marked by the increasing value of property (land and buildings) which will further encourage the growth of the trade and public services sector. This growth in turn will increase the attractiveness of the region as a destination for urban community trips in the daily cycle. This will increasingly put pressure on local traffic loads (Krehl, 2015; Duranton & Puga, 2005). On the other hand, inhabitants of local settlement clusters who have limited capital resources will be faced with a dilemma to sell or utilize their assets in pragmatic ways which in turn can trigger the growth of slum areas. If the 'sell' option is chosen, the logical consequence is the decreasing population of the local area which tends to move to the peri-urban area of the city (whose property prices are cheaper) which in turn also has an impact on the acceleration of sprawl. The increasing existence of 'attractive' trade and service facilities in the region can encourage job search speculation for a large proportion of the urban population even from the surrounding rural areas to migrate into the city of Manado. This possible surge in urbanization can eventually lead to the presence of squatter in a number of places within the area around the city center. With the emerging of slum and squatter in the same segment, the risk of disaster will be very high due to the high level of exposure and vulnerability of the number of residents and built-up areas that have the potential to be affected by various types of hazards (Patel et al, 2009).

In the peri-urban area (radius >5 km from the city center of Manado), mainly Malalayang, Mapanget and Bunaken sub-districts, with low density conditions, especially with a wide coverage of built area which is still growing, dependence on private vehicle or informal transportation services will increase significantly. The use of private vehicles with a relatively long average travel distance (from and to the city center whose determination as a point of origin and destination is still relatively strong) will increase vehicle fuel consumption along with the increase in the number of emissions even though it tends not to be concentrated (Watkins et al., 2007; Jianxin Wu et al., 2016; Bertaud, 2002).

In the same segment, economically, condition of cheap land prices, as well as the more comfortable air quality and microclimatic condition, tend to encourage the development of the property business, especially housing, which will accelerate horizontal development of built area with a 'leapfrog' , 'ribbon' and 'scatter' pattern. This condition will increase the fragmentation of green open space in this area and increasingly encourage sprawling (Angel et al, 2009). This condition, in turn, requires the extensification of basic urban infrastructure networks that require higher construction and maintenance costs that will burden the financial capacity of local governments (Gao et al, 2018; Bertaud & Richardson, 2004; Burchell & Mukherji, 2003).

The Options of Spatial Policy

To anticipate the potential of the above problems, some logical recommendations regarding the spatial policy options that need to be implemented as solutions to the various problems in question, can be described as follows. On the segment of the downtown area (<5km from the city center), the policy that can reduce the ratio of trips on private vehicle is urgent (Brownstone & Golob, 2009; Ewing & Rong, 2008; Bertaud & Richardson, 2004). One desirable policy is to develop a mass public transportation system that is cheap, safe, comfortable and able to reach the distribution of points of origin and destination in this region. This mass public transportation system needs to be integrated with some transit points for community groups located in peri-urban areas whose dependence on private vehicle use to access the city center is still high. With the presence of these transit terminals, accessibility to and from the city center by peri-urban dwellers can be switched from private vehicles or informal public transportation services to mass public transportation facilities that can reach the city service center. This policy at least provides wider options for people, with the hope that they tend to choose this mode because it is more economical than the use of personal modes.

In the same segment, the development of the Transit-Oriented-Development (TOD) area which based on the concept of urban walkability should be considered. This policy is essentially an effort to maximize the number of residential, business and recreational spaces as a multi-functional cluster that can be reached by walking. This strategy usually requires the presence of communal parking spaces as well as a safe, comfortable and aesthetic infrastructure system for pedestrians or bicycle users that is able to connect various functional area in one multi-functional cluster unit (Widyaharia & Indradjatia, 2015). Other policy that should be considered in this downtown area segment is the policy to increase the proportion of green open spaces within the region to anticipate the declining microclimatic conditions, especially air quality. This can be achieved by the application of strict provisions in terms of the Basic Green Coefficient which can guarantee the existence of green open spaces that can ecologically neutralize the concentration of motorized carbon emissions or from other sources (Wu et al., 2016; Watkins et al., 2007; Bertaud, 2002).

Other policy which is crucial to this segment is the policy that can increase the carrying capacity of the land to anticipate the increasing economic value of land. This policy in particular can be implemented by enforcing building codes that can encourage vertical physical development, especially the provisions of the Building Coverage Ratio and the Floor Area Ratio with relatively high percentages. In this downtown area, there should be a policy that can guarantee the sustainability of the local settlement clusters, especially those that have specific cultural or historical setting. These settlement clusters should be designated as mixed use zones with the provision of careful zoning regulations, so that the inhabitants will have the opportunity to obtain added value from the strategic value of the region economically. These clusters need to be controlled with legal provisions in the form of Building and Environmental Codes, which are accompanied by special policies such as revitalization, gentrification and carefully planned urban renewal / redevelopment.

In this segment there should be a policy that can anticipate the growth of squatter in certain zones, This policy will require a strict system of supervision and enforcement. Considering the high level of exposure to various hazards, in this downtown area there should be a policy to develop a comprehensive disaster risk mitigation plan, whether at the pre-disaster level, during disasters to post-disaster, especially for high frequency hazards such as floods, earthquakes, fires, disease outbreaks, et cetera (Patel et al, 2009). On the peri-urban segment,

some policies that should be considered to be implemented are as follows. Dependence on the use of private vehicles in this area needs to be neutralized by preparing public transportation lines that can at least connect local service centers with transit points at peripheral segments of the area around the city center. With the availability of public transportation facilities, the proportion of private vehicle use is expected to be significantly reduced. Within this peri-urban area the local service center clusters are needed to be strengthen so that they can be the alternative destinations for travel other than the city center (Gao et al, 2018). This policy in turn will significantly reduce the proportion of trips from this peri-urban region to the city center.

Other policy is to strengthen the quality of road network infrastructure that can connect the service center of a certain peri-urban area with other peri-urban areas (Gao et al, 2018). This effort will assure that the travel between peri-urban areas can be done directly without going through the downtown area with relatively high traffic loads. This can be achieved by increasing the capacity and quality of the city's ring roads. To anticipate the sprawling phenomenon in the peri-urban area, certain policy should be applied to control the property development activities, especially housing and industry (Gao et al, 2018), so that they can be carried out with an efficient and compact land use strategy (Angel et al, 2009). The implementation of this policy is expected to reduce the financing needs of investment and maintenance of infrastructure. Another policy to reduce the rate of sprawling phenomena is to review the implementation of building codes such as the Building Coverage Ratio (BCR) and the Floor Area Ratio (FAR), which if possible needs to be increased gradually. This strategy will increase the carrying capacity and economic value of the land and encourage the vertical growth.

CONCLUSION

Based on the density profile indicator, the current condition of the Manado municipal can still be seen as a city with a monocentric spatial structure, even though its significance is diminishing in the segment of peri-urban areas that are beginning to transform into polycentric structure. The current spatial structure are associated with a variety of potential problems. In downtown area some potential problems are the threat of acute traffic congestion, decreasing air quality and microclimatic condition, potential growth of slum and squatter, and the increasing risk of disaster. In the peri-urban areas, the potential problems includes the increasing dependence on private vehicle, the increasing fragmentation of green open spaces and the increasing needs of urban infrastructure extensfication. Regarding to the potential problems some spatial planning policies should be considered. In the downtown area, the policies recommended are the development of mass public transport system, TOD service center clusters, sustainable green open spaces, strict building codes encouraging vertical growth, revitalization of cultural or historical settlements, anticipation of slum & squatter, and preparation of disaster risk mitigation plans. In the peri-urban areas, the policies recommended are the development of public transportation lines connecting local service centers with the mass public transport terminals, strengthening of local services centers, development of connecting road networks between peri-urban areas, and the controlling of property development.

The effort to understand the characteristics of the spatial structure of Manado municipal in this study was carried out with an approach limited to the population density profile as indicator. The identification of spatial structures in the city can still be done with other indicators, including the daily movement patterns as the dynamic side in the urban density concept. Identification of the spatial structure of Manado city can also be enriched by reviewing

other density parameters, especially building density that can be done associatively with parameters of population density. In this study, the tracing of population density as indicator of the spatial structure of the city is still carried out based on observations of population data at the district and subdistrict levels. The search can still be sharpened through observation in a more detailed population database, in this case based on a specific grid pattern so that the characteristics of population density (also buildings) of the city can be observed more comprehensively.

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