THE SPATIAL PATTERNS OF THE CARRYING CAPACITY OF ROAD IN SINGARAJA CITY, BALI
(Geographical Perspective Review)

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ABSTRACT

The research was conducted in Singaraja City, Bali Province in order to analyze the spatial patterns of the carrying capacity of the road. The method used in this research was survey method. Data was directly collected by measuring the parameters of the road's carrying capacity. This research was analyzed by quantitative descriptive method.

The results showed that in a period of time, the maximum carrying capacity of the roads, either functioned as arterial or collector, in the core city has a very wide variation i.e. from the category of optimum to beyond high. Meanwhile, in the kernel, it appears that the maximum carrying capacity in each day, both during holidays and effective days, has a wide variation. However, the maximum carrying capacity of the road which categorized as beyond high doesn't happen in all road networks in this zone. This research also found that the suburb shows a trend of high homogeneity symptoms of the maximum level of traffic congestion. This phenomenon can be found in each period of day due to its road's maximum carrying capacity. It indicates that the spatial distribution of the road's maximum carrying capacity in Singaraja City associates with the urban morphological zones and the road's functions.

Keywords: spatial patterns, the carrying capacity of road, urban morphological zones

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1. INTRODUCTION

City is an area which experiences development over time. This development is very dynamic, either in terms of social, economic, cultural or urban spatial (Yunus, 2005). Basically, a city must develop regarding the environmental ethics. The essential ethic is the limitation of urban living space especially in providing resources for the increasingly complex and unlimited needs (Keraf, 2005).

The development of socio-cultural and religious values in Hindu community in Bali implicate in their view of religious activities i.e. religious ceremonies and customs including the Hindu community in Singaraja City city. Several religious and traditional activities have their needs for roads utilization, both as a media to reach their purposes and as a venue of these activities. Indirectly, this will bring consequences on the pressure on the road's carrying capacity to accommodate traffic flow, and usually created accidentally traffic congestion.

Accidental occurrences is the peak time traffic congestion is not due to the normal traffic conditions, but its influenced by the temporal dimension in accordance with the religious-cultural values of Hindu community. This resulted in a general road users will not be able to predict a reduction in the width of the road or slowing the flow of traffic as a result of the religious-cultural activity. Traffic congestion based on a review of this religious-cultural activity gave rise to two variants of a traffic congestion, i.e. the accidental passive (passive due to the reduction of road width is generally only occurs in front of or around the location of the ceremony, and spatially that location becomes the main point of traffic congestion) and accidental active (is slowing traffic flow on a road network that is actively used by the community for the convoy to the location of the ceremony, and resulting in a slowdown even traffic flow can be stopped for sometime according to the speed of the convoy).

The center of a socio-economic activity is a location with high complexity level of traffic. Negative phenomenon of urban transport which then arises is traffic congestion. It is a traffic condition on some roads whose utilizations are increased, as characterized by slower vehicles speeds (Dimitriou, 1989). This complexity leads to high pressure from the road users at peak hours.

Although the congestion is not yet to be classified as constant and total, the number of private motor vehicles, and with their different specificities, indicates the presence of the trend of increasing levels of traffic congestion, especially in the zone of core city in Singaraja. This tendency will result in a decreased carrying capacity of the roads to accommodate the population movement, while the demands on the efficiency and effectiveness of transportation infrastructure increases with the increase of population and its various activities in different urban morphological zones. This is because there are variations in the dominance of land use in each zone of the urban morphology (Hutchison, 2010).

Construction of various urban functions and city population growth with its variety of activities encourage the emergence of problems in urban areas, and one of them is the transportation problem. Singaraja City has a relatively high population growth leading to an increased demand for transportation services to the urban functions, which are far from their homes, such as shopping centers, offices, educational institutions and others. However, the road's carrying capacity has limitation in accommodating the increasing population mobility which results in traffic congestion. Therefore, this phenomenon needs to be studied in order to set the appropriate direction of related policies so that the higher level of traffic congestion can't emerge and the new one in a new location can be anticipated as well.

The phenomenon of traffic congestion can't be separated from the specificity of functions owned by Singaraja City. Firstly, the developed educational institutions in Singaraja City, from ground level to higher education, have a strong appeal for the school age population from different areas, also regarding Universitas Pendidikan Ganesha (UNDIKSHA) as the only college which provides educators in Bali Province. Secondly, the centers of economic

activity such as traditional market and supermarket become the shopping centers of daily needs as well as job opportunities. Considering this character in Singaraja City, population movement will result in traffic congestion. This background bases the analysis in this research which concerns on the spatial pattern of the road's carrying capacity in Singaraja City.

2. RESEARCH METHODS

This research used survey method and was conducted in Singaraja City by taking three urban morphological zones i.e. the core city, the kernel and the suburb (see Appendix 1). Data was collected by direct field measurements of the parameters of the road's carrying capacity. The parameters consists of traffic including traffic volume, road's capacity, vehicle speed and the free flow speed (Direktorat Jenderal Bina Marga, 1997). Through the calculation of these four variables, the carrying capacity of a road network can be determined. It shows the quantitative side of several traffic conditions on the road network.

The population in this study was all road networks in Singaraja City, then, samples were selected proportionally from each group of the population under the consideration of the road network's function and density. The samples are relatively same in numbers and evenly distributed in each zone (Kartono, 1996).

Therefore, there are 6 samples of road networks which are 2 networks in the core city i.e. Jl. Gadjah Mada as the arterial road and Jl. Ngurah Rai as the collector one, 2 networks in the kernel i.e. Jl. Surapati as the arterial and Jl. Sudirman as the collector, and 2 networks in the suburb i.e. Jl. Mayor Metra as the arterial and Jl. Laksamana as the collector. Furthermore, data was analyzed by quantitative descriptive technique.

3. RESULTS AND DISCUSSION

The road network is a means of transportation whose utilization is necessary in maintaining the balance of the carrying capacity of the road. Conceptually, carrying capacity of a road is a condition where a number of vehicles are viable to pass through a point in the road network during a certain time interval.

As mentioned earlier, this research was conducted in Singaraja City by taking three urban morphological zones i.e. the core city, the kernel, and the suburb. The core city is an urban morphological zone whose spatial structure is dominated by urban built-up areas (Hutchison, 2010). Furthermore, Hutchison mentioned that it tends to form a specific area, such as shopping center (mini market, supermarket, and the plaza), an area for offices and other urban built-up areas. This spatial structure becomes the indicator of the traffic complexity which affects the spatial distribution of the carrying capacity of the road in the core city.

Carrying capacity of a road is determined by traffic behavior such as road's capacity and free flow speed which is strongly influenced by the spatial structure in an urban morphological zone, particularly through the side barrier class. Besides these two behaviors, traffic volume and average vehicle speed are the determinants in the carrying capacity of the road.

An urban morphological zone whose spatial structure is dominated by residential buildings is defined as the kernel (Hutchison, 2010). Besides residential buildings, several socio-economic activity centers can be found in this zone as the minority, such as shopping centers, educational institutions, and other public services. This spatial structure becomes the indicator of traffic complexity that varies in its influence on the spatial distribution of the road's carrying capacity in this zone.

The suburb is an urban morphological zone whose spatial structure is dominated by agricultural land i.e. irrigated rice field, dry cultivated land, and plantation (Hutchison, 2010). However, in some parts of the road, there are also many non-agricultural activity centers, such as shopping centers, educational institutions, and other public service facilities, albeit in a small intensity. This spatial structure becomes the indicator of the various categories of the road's carrying capacity in this zone.

Based on the analysis of the spatial distribution of the carrying capacity of the road in each urban morphological zone (see Appendix 2), the macro comparation of each spatial distribution in Singaraja City is as shown in Table 1 below.

Table 1. The Spatial Distribution of the Carrying Capacity of the Road in Singaraja City

No	Time Period		The Core City		The Kernel		The Suburb	
			CCR min	CCR max	CCR min	CCR max	CCR min	CCR max
(1)	(2)		(3)	(4)	(5)	(6)	(7)	(8)
1	Holidays	06.00-08.00	Op.	Op.	Op.	B.L.	Op.	B.M.
		12.00-14.00	Op.	B.M.	Op.	B.M.	Op.	B.M.
		16.00-18.00	Op.	B.M.	Op.	B.M.	Op.	B.M.
2	Effective Days	06.00-08.00	Op.	B.M.	Op.	B.M.	Op.	B.L.
		12.00-14.00	Op.	B.H.	Op.	B.H.	Op.	B.M.
		16.00-18.00	Op.	B.M.	Op.	B.M.	Op.	B.M.

Source: Primary Data Analysis, 2010

Carrying Capacity of the Road:

Op. = optimum B.L. = beyond low B.M. = beyond medium B.H. = beyond high

From Table 1, it can be observed that there is a very high variation of the category of the road's maximum carrying capacity in each morphological zone in Singaraja City, both during holidays and eff ective days. In the core city, both the arterials and the collectors show that the road's maximum carrying capacity based on the time period has a very wide variation i.e. from the category of optimum until beyond high. Overall, the road networks in the core city have the same category of road's maximum carrying capacity which is beyond high around noon on effective days. This reflects the level homogeneity of the maximum traffic congestion in the core city.

Meanwhile, the road's maximum carrying capacity in the kernel on each period of day, both during holidays and effective days, has a wide variation. But, based on observations, the road's maximum carrying capacity which is beyond high doesn't happen in all road

networks in the kernel. This category only happens on the arterial road networks, while it becomes beyond medium on the collector road networks. This represents the symptoms of the level homogeneity of the maximum traffic congestion in this zone.

In the suburb, there is a trend of significant homogeneity symptoms according to the level of the maximum congestion. These symptoms are reflected from the road's maximum carrying capacity in each period of day, both during holidays and effective days, which are all the same. Most of the highest road's maximum carrying capacity in this zone is beyond medium, but it becomes beyond low during morning on effective days on the arterials only.

In 2001, Rosilawati used the measurement of the level of road service to determine its ability and condition in accommodating the population movement, especially at peak hours in Semarang-Mranggen Corridor. By calculating the road service level which is based on the data of road's capacity and traffic volume, the results showed that along this suburban corridor the road service is poor due to the lower road's capacity than the traffic volume during peak hours. Since the research excluded the average vehicle speed and the free flow speed as the main variables in the calculation of road's condition, and the emphasis of the analysis i.e. the road's capacity and the traffic volume, the calculation of the road's condition especially in the related suburbs is still partial.

Based on the empirical facts in the study area, there is variables performance of the traffic behavior which was excluded from the findings in the research conducted by Rosilawati (2001). This indicates that although the value of traffic volume exceeds the road's capacity, the value of the average vehicle speed is still above the free flow speed in a road network; therefore, it can be concluded that the road's condition is still pretty good. Regarding this research, it is found that the road's condition in the suburb of Singaraja City, as viewed from the road's carrying capacity, is categorized as beyond medium.

Sinha (1980) revealed the infuence of transportation network, especially the road network in built-up areas, i.e. better existing road network is followed by wider built-up areas. This also represents the extending urban physical environment or the emerging urban

activity centers in a region. This result is consistent with the Manheim's concept of the integrated urban transportation system which states that there is a very strong causal relationship between transportation, acitivity, and traffic systems. This leads to increased population movement in reaching the urban activity centers which are built from the good road network.

Empirically, the construction of road networks especially in the study area is relatively stagnant, while the rise of the population movement resulted from the development of urban activity centers becomes higher. This fact emerges the condition of an increasingly unequal road's condition, especially during peak hours. This can be observed from the traffic behaviors i.e. the value of the traffic volume exceeding the values of road's capacity and the average vehicle speed.

Based on the results of field observations on these three urban morphological zones, it can be said that the spatial distribution of the maximum carrying capacity of the road which is beyond high is clustered in the closest zone to the core city, especially the road networks whose functions are as the arterials. In the closest zone to the suburb, the collectors have the category of beyond low for their maximum carrying capacity of the road.

4. CONCLUSION

Based on the analysis results and discussion in this study, it can be concluded that the closer an area to the core city and the higher the hierarchy of the road's function, the more it will exceed the high category of the maximum carrying capacity of the road. This indicates that the spatial distribution of the maximum carrying capacity of roads in Singaraja City associates with the urban morphological zones and the road's function.

To prevent the negative impacts of traffic congestion phenomenon is not expanded, both in terms of spatial distribution and temporal terms, it is recommended to apply traffic management at peak hours are not only oriented to the variable traffic volume and road

capacity, but based on empirical findings of this study, researchers also propose to use a variable speed of vehicles and the average free flow speed on each road network contained in a particular zone of the urban morphology.

Through these two additional variables, the results of this study are expected to provides benefits as a discussion of the development effort is related to the study of traffic congestion in terms of the carrying capacity of roads in urban areas, which can be used as a starting point to do the kind of in-depth study or research within the scope of the wider.

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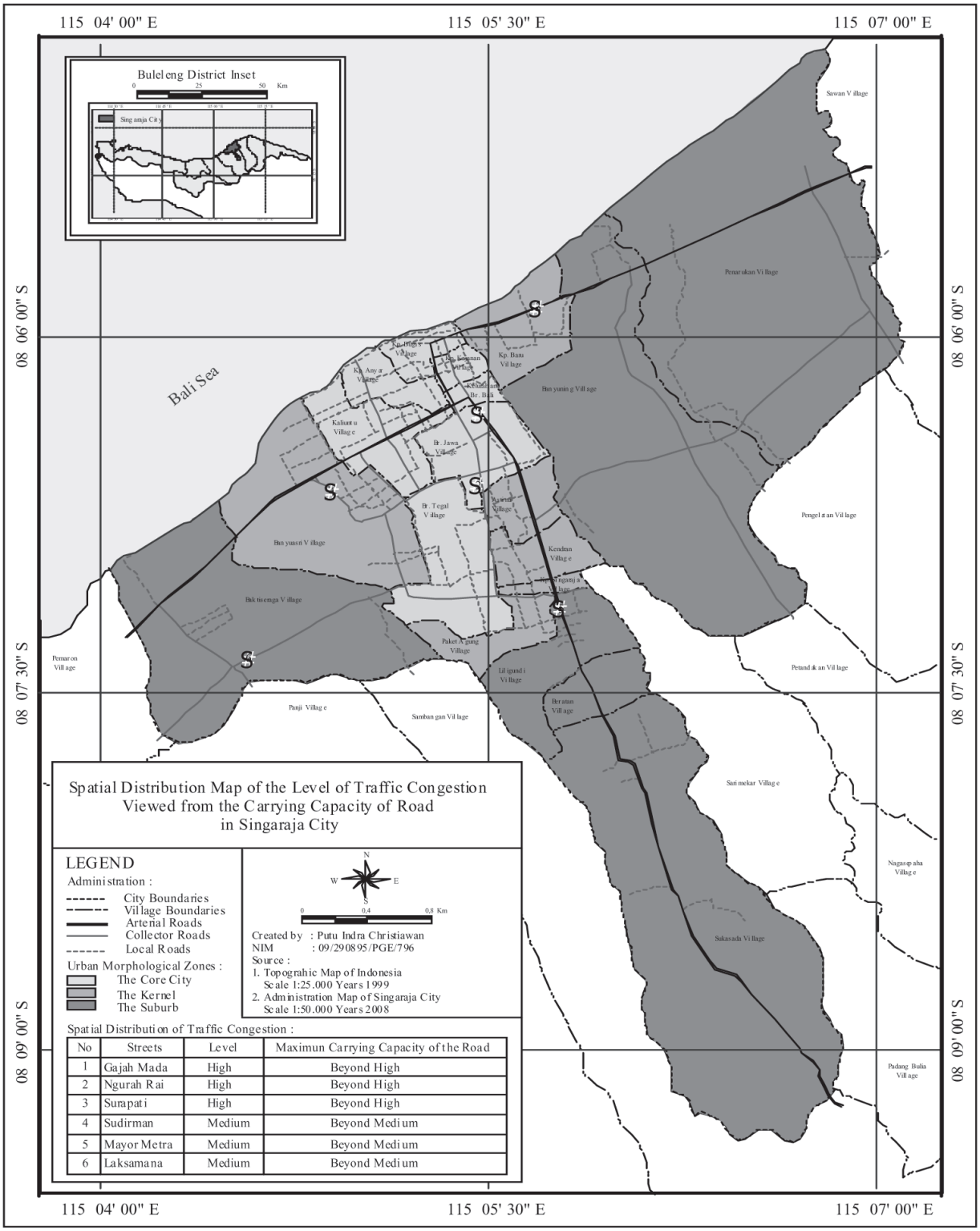
Appendix 2. Spatial Distribution Map of the Level of Traffic Congestion Viewed from the Carrying Capacity of Road in Singaraja City



No	Streets	Level	Maximun Carrying Capacity of the Road
1	Gajah Mada	High	Beyond High
2	Ngurah Rai	High	Beyond High
3	Surapati	High	Beyond High
4	Sudirman	Medium	Beyond Medium
5	Mayor Metra	Medium	Beyond Medium
6	Laksamana	Medium	Beyond Medium