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Use of Engineering-Educational-Empowerment Model to Improve the Integrated Traffic Impact Analysis and Environment Impact Analysis Results

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ABSTRACT: In order to control road carriage way capacity and/or road environment degradation due to transport activities, the Traffic Impact Analysis TIA document has been directed to be integrated within the Environment Impact Analysis EIA document. However, only medium and high trip attractiveness was considered. Consequently, cumulative impact due to dense small scale concentrated in a certain corridor not only decrease road capacity but also increase road environment degradation. These unintended situations, especially at fast growth corridors, was recorded, including the parking index, on-street parking impacts due to inadequacy in existing parking space capacity. This activity aims to socialized and discussed the technical and environmental impacts due to on-street parking in order to improve better knowledge and transport policy decision. Therefore, an integrated approaches - using a Focus Group Discussion - based on engineering, educational and empowerment method was undertaken to identify a change in stake holder's perception towards the correlation between transport and land use. It was found that, although within low trip attractiveness level category, but a dense small scale of activities produces great roadside friction and contribute negative impact on roadway capacity and air pollutant essence. This strongly indicate that a micro zoning regulation is required to control the type, number, scale and dense of social-economic activities, particularly in fast growth corridors.

KEYWORDS: Effective carriage width, fast growth urban area, parking index, micro-zoning regulation

I. INTRODUCTION

As a connecting hub of the center of strategic socio-economic activities, the high accessibility and mobility level is required [1]. The degree of saturation (DS), accident risk level and environmental degradation are usually used to describe the traffic impact analysis (TIA) and/or environment impact analysis (EIA) due to the presence of high trip attractiveness activities in a certain corridor [2]. The DS is a ratio of total traffic volume and roadway capacity. If it closer to 1.0, then the level of service (LoS) of a road segment is very low, depending on traffic flow characteristics (traffic volume, travel speed, and traffic density). Speed is a function of traffic density and/or road side friction level. The higher the road side friction level the lower the speed, and the lower the speed, the lower the level of service.

In the context of traffic management and engineering, the increasing number of traffic jam zones represent the low level of accessibility because the travel speed was low. Understandably why a number of riders usually tend to increase their vehicle speed to avoid and/or to be released from such traffic congestion zones [3], [4]. This strongly influences the traffic volume as well as traffic accident risk level.

The basic idea of this research is triggered by the following reasons: 1) the presence of an indication of difficulties in the management of right of way occupied by small-scale socio-economic activities along the urban roadway 2) such occupation not only reduce roadway shoulder but also generating the on-street parking which in turn reduce the effective width of roadway, 3) a reduce in the effective width of roadway may reduce travel speed, traffic volume and road capacity as well.

Since the road capacity was determined based on an assumption that the condition of traffic is stable and the minimum effective width of roadway is 3.5 m [5], [6], and only large scale of activity was directed to provide the off-street parking space then the cumulative impact of a reduce in roadway lane width and travel speed due to the on-street parking index surrounding small-scale of activities is required to be investigated because the related previous research was more focused on the evaluation of the existing parking space capacity [7] without considering the effect of the existing number and density of small-scale activities surrounding.

It should be noted that thus far, although the needs of integrated TIA and EIA documents is a mandatory need but in fact, the recommendation of TIA has not been adequately accommodated in the EIA document due to several reasons:

1) TIA was more focused on traffic engineering aspects, neglected the traffic safety and comfort analysis 2) ignoring effect of the presences of small-scale activities surround the study object 3) the role of education and empowerment was neglected whereas previous study strongly recommend it [8]. .

Therefore, the output of this study is intended to support the determination of public transport policy by local authorities (both public work and transportation departments), during the road network planning and evaluation stages. It is thought that by considering the negative impact of inadequate parking space of small-scale activities during the creation of TIA and/or EIA documents, the safety and smoothness as well as comfort trip may be monitored and handled proportionally. Consequently, the aims of this study are: 1) to identify the effect of on-street parking to carriageway width characteristics 2) to determine the effect of a reduce in roadway width to the fluctuated travel speed measured and its implication on TIA and/or EIA products 3) to recommend the appropriate strategy to accommodate the negative impact due to the presence of dense small scale 0f activity.

II. METHOD

In order to improve better understanding toward traffic engineering and management policy due to various trip attractiveness activities, a focus group discussion (FGD) followed by 21 participants was conducted by involving not only the transportation division, or traffic policy officer, but also public transport operator and daily news reporter. During the FGD, the poor traffic and road environment characteristics occurred due to on-street parking vehicles was socialized and discussed, focused on the negative impacts due to the trip attractiveness generated by a dense small-scale activity along a certain corridor obtained from a number of previous TIA documents undertaken by the authors. This information is used to arise the participants' awareness towards the effect of current substance of TIA and/or EIA guideline and regulations.

Subsequently, to confirm it, a field observation at Frans Leburaya Street (an urban arterial roadways which suffered a reduce in the effective width of roadway due to roadside friction conditions) was conducted to directly evaluate the actual traffic volume, travel speed and road capacity attracted and/or generated by the increasing number of small-scale of activity (street vendors) along the road.

Subsequently, the effect of a reduce in the effective width of roadway to travel speed was assessed by comparing the road capacity by using the Indonesian Highway Capacity Guidance (IHCG) year of 2023. Previous studies reported that a change in roadway's width may affect the travel speed which in turn may decrease the road performance [9], [10]. Therefore, a reduce in roadways 'width at a certain corridor should be limited, including due to the presence of a dense small-scale activities - such as street vendors - surrounding the social-economic building within a large scale of trip generation category level, as it was occurred in the study location.

It should be informed that the determination of study locations was conducted based on the result of initial field observation (visual observation) intended to identify the presence of a reduce in the effective width of roadways due to roadside friction activities, especially due to on-street parking. In addition, the condition of traffic volume was also investigated. The chosen roadway characteristics are as follows:

1. A secondary arterial road (Frans Leburaya Street) was chosen (a 2/2 un-divided roadway; lane width of 9 m).
2. The general picture of a reduce of effective width of roadway due to on-street parking vehicles can be drawn as follows: a) it was triggered by "warung" (mini-restaurant) and other types of street vendors activities; b) road side friction level was strongly influenced by entering-exiting vehicles movements.
3. A significant change in travel speed was occurred on road segment located nearby the on-street parking activities.

Subsequently, according to Indonesian Highway Capacity Manual [6], road capacity is calculated using Eq.1 as follow:

$$C = FC_{cw} x\ FC_{sf}\ x\ FC_{sp}\ x\ FC_{cs} \qquad (1)$$

Where is:

FC_{CW} = road capacity adjustment factor due to effective road width lane

FCSF = road capacity adjustment factor due to road side friction level

FCSD = road capacity adjustment factor due to the composition of traffic volume (split direction)

FCCS = road capacity adjustment factor due to city size

Road performance indicators such as degree of saturation and travel speed as well as accident risk level were used to describe the effect of parking on-street restriction schemes. Therefore, the following criteria was used to evaluate it:

1. Degree of Saturation/DS i.e., the ratio between traffic volume and road capacity. Indonesian Highway Capacity Manual [6] stated that if DS ≥ 0.85 then it means such road segment has started experiencing capacity constraints, visually indicated through a progressive decrease in vehicle speed, in line with the increasing in the DS value.
2. Travel Speed i.e., the distance travelled by a vehicle in a given unit of time. In this particularly case, such speed was determined based on spot speed value of a number of sample vehicle when passing through the road

segment in front of Amaris Hotel and surrounding culinary area.

3. Free flow speed i.e., traffic flow speed prediction for various road conditions and environments.

In this study, the change in free flow speed is predicted through 3 restriction schemes namely: 1) no vehicle parking at all; 2) vehicle parking only allowed in one side; 3) two side on-street parking scheme. It should be noted that the 2nd scheme corresponds to or refers to the existing parking conditions at study location.

This technical step is carried out not only to show but also to concurrently educate that these strategic and important result or findings obtained during this activity could be used to improve better perception based on the engineering approach. Therefore, the subsequent FGD could be used to inform the technical effect of on-street parking as a represent of educational model. It is hoped that by using these technical, educational and empowerment approaches, the institutional capability could be improved appropriately, especially during the evaluating of TIA and/or EIA document process which in turn may affect the land use plan products.

III.RESULT AND DISCUSSION

A. Road geometry and environment characteristics

The effective width of roadway and roadside friction level can be seen in the following table. Table 1 shows a change in the effective width of roadway occurs on the road segment within the high level of roadside friction category, especially caused by the on-street parking and entering-exiting vehicles' movement surrounding as can be seen in Figure 1..

Table 1. The effective width roadway and side friction level characteristics

Name / Type of Road	Road Width (m)	Effective Width of Roadway (m)	Side Friction level	Remark
Frans Leburaya (un-divided, secondary arterial roadway)				
Segment 1	9	9	High	Hotel Amaris zone, entering-exiting vehicle
Segment 2	9	5	Very high	Depot Ria zone, on-street parking vehicle

Previous studies reported that the exiting-entering vehicles' movement, especially right turning movements, play major role in traffic accident risk [9], [11] and environment degradation [2]. This interesting and strategic finding should be appropriate informed and/or educated. It is thought that such educational effort may improve better understanding which in turn may affect one's behavior and/or produce a better and right perception during producing a transport policy.

Figure 1. The on-street parking characteristics

B. Speed characteristics

Table 2 below explicitly shows that the average speed at each road segment was fluctuated. At segment 1, the right turning movement due to exiting-entering vehicles surrounding Amaris Hotel doesn't affect the motorcyclist's travel speed. This may be influenced by the long-distance headway of major stream. It may occur due to the available roadway width of 4.5 m, greater than the ideal roadway lane width of 3.5 m as previously mentioned above.

Table 2. Speed characteristics due to a difference in roadside friction level

Name and Type of Road	Road width (m)	Effective width pf roadway (m)	Side friction level;	Speed (km/hour) MC	LV	HV
Frasn Leburaya street						
Segment 1	9	9	High	53	51	45
Segment 2	9	5	Very high	45	37	29

However, the average speed of light and heavy vehicle tends to decrease due to the increase in roadside friction level as can be seen in segment 2. This strongly indicates the risky behavior of motorcyclist. Such risky behavior constantly shows in the average speed of motorcyclist in all observed road segment, regardless the fluctuated level of roadside friction. This confirms that the average speed of motorcyclist is relatively constant in any conditions [12]–[14].

This finding strongly indicates the requirement of speed monitoring at risky location, especially roadway within high level of roadside friction category so that the accident risk could be reduce. This issue should be considered seriously because previous concerned studies reported that fatal accident events have been occurred due to speeding,

including due to the chosen of inappropriate speed [4], [15], [16]. The inappropriate speed choice and on-street parking phenomena may increase the number of traffic conflicts due to limited sight distance. As a result, this risky situation should also be considered when evaluating the TIA and/or EIA documents. Therefore, again, an appropriate educational effort should always be addressed to increase better understanding and better traffic accident risk management based on speed limit determination policy.

However, during the FGD it was found that most participant realized that the on-street parking should be limited because it may affect the travel speed as well as traffic accident risk. This confirms the related important and interesting finding obtained from the result of similar previous studies [17], [18].

C. The difference of road capacity due to the differences in the effective roadway width

A previously mentioned, a related study has reported that generally, a reduce in roadway width may also influence the PCE values for motorcycle and heavy vehicle, i.e., greater than the standardized value as it was recommended by IHCM'97 and IHCG'23 [19]. This strongly indicates that the factual PCE should be used when evaluating the road network performance, especially at roadway that suffered a reduce in their width of roadway.

In this particular case, such reduce in road carriage width may significantly affect not only the road capacity, but also the degree of saturation, free flow speed and level of service. A reduce of 50.21% of DS could be achieved if the on-street parking was strictly prohibited. In turn, it may reduce the free flow speed by up to 24.49% so that the level of service may decrease significantly. The result of visual observation on study location validates it, i.e. that a reduce in the effective roadway width significantly affect the travel speed which in turn may affect the traffic volume, degree of saturation and road link performance as well.

Subsequently, there was an interesting finding during the field observation i.e., that the available off-street parking space was reduced by the presence of additional business space. This strongly indicates not only the lack monitoring in parking space utilization by local authority, but also poor awareness or responsibility of building owner for providing appropriate parking space capacity.

Consequently, local authority should improve their attention due to the presence of socio-economic activities surrounding the proposed main building presented in each TIA document.

D. Implication of Study Result

The finding result is worth to be considered when determining the appropriate model of traffic engineering and management, especially when conducting a traffic impact analysis (TIA) or during evaluating the performance of urban road network. This is an important notification because traffic engineering policy should be suited to specific condition on each road segment. This suitability is required to guarantee the achievement of road network management's effectiveness which is required to increase road user accessibility, mobility and safety needs. The accomplishment of this target may increase road user awareness and reduce their risky behavior.

The implementation or the use of this PCE model is also recommended for unsignalized intersection, particularly if there is a difference in road function classification in their approaches lane as strongly recommended by previous researcher. The contextualism of traffic volume which is produced confirmed it, especially based on the impact of right turning movement [2].

Subsequently, since the TIA document should be integrated within the EIA document then these findings strongly indicates that:

1. The substance of EIA document should consider the effect of small-scale activities surroundings to the bearing capacity of a certain urban zone
2. The substance of TIA should be developed by taking into account the traffic accident risk analysis as well as the transport pollutant effects
3. The similar dissemination or FGDs should also be conducted in other districts so that it may produce a greater responses or considerations toward the requirement of a micro-zoning regulation which may arrange the allowance type and number of buildings, including their scale of activities and density along a certain corridor, especially at fast growth urban corridors.

IV. CONCLUSION

Conclusion that could be drawn based on the result and discussion above are:

1. A decreasing in effective width of roadway due to the inadequacy of parking space capacity on street vendors activities has a significant impact on the effective width of roadway which in turn may affect the travel speed
2. A change in travel speed not only influencing the road capacity and its level of service, but also road environment quality, especially traffic accident risk.
3. Consequently, the presence of on-street parking due to small-scale activities should be limited by determining an appropriate micro-zoning regulation, especially at urban fast growth corridor. In addition, this issue should be properly accommodated in the EIA documents.

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