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NON-TECHNICAL APPROACH AS TRAFFIC CONTROL STRATEGY (CASE STUDY OF BOGOR CITY)

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ABSTRACT: *The objective of this research was to model the relationship between the traffic in Bogor City in terms of non-technical aspects (i.e. ethics and behavior) among three categories of respondent namely private vehicle drivers, public transport drivers, and pedestrians. Data was collected using a structured questionnaire. The data was then analyzed using SmartPLS software. The results indicated that ethics and behavior of private vehicle drivers, behavior of public transport drivers, and ethics and behavior of pedestrian all had a significant relationship with the traffic of Bogor City with behavior of public transport drivers becoming the most significant predictors of traffic of Bogor City. The implications from this research are further explored as recommendations for the Government of Bogor City.*

KEYWORDS: Behavior, Bogor City, Ethics, PLS, Traffic.

INTRODUCTION

High community mobility in urban area requires the city government to build transportation facilities and infrastructure, as well as an adequate traffic system. The regulation of road transportation in urban area has a strategic role in supporting economic development and realizing national connectivity and integration. All mobility and transportation system is inseparable in the planning of transportation facilities, infrastructure, and system in an urban area. Such condition occurs in some cities in Indonesia, including Bogor City as one of the buffer city of Jakarta, the capital city of Indonesia.

One of the specters for an area with high mobility like urban area is traffic jam or traffic congestion. That also happens in Bogor City. The growth of private vehicle and also public transport in Bogor City, especially the City Transport or *Angkutan Kota* (*angkot*), which increases from year to year causes a traffic congestion in nearly all Bogor City area. Surprisingly, a transportation application called Waze in 2016 even placed Bogor City as a city with the second lowest driver satisfaction index in the world (Waze, 2016), beating Jakarta City.

Several initiatives from the Government of Bogor City were then established to overcome this traffic problem, such as the use of shifting system for *angkot*, the operation of Trans Pakuan buses as a mass transportation facilities, and the implementation of one-way-system in Bogor Botanical Garden area. Unfortunately, those policies have not been able to overcome the existing traffic congestion in Bogor City. From that phenomenon, the researcher views that traffic congestion in Bogor City is not only the impact from the lacking facilities and infrastructure or policies from the local government, but driving behavior and ethics also become one of the important factors for the creation of a smooth traffic.

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Several researches regarding urban traffic congestion had been carried out. Mustikarani and Suherdiyanto (2016) stated that technical factor like road and human factor (attitude and behavior on roadway) became factors affecting the traffic congestion of urban roadways. Rozari and Wibowo (2015) in their research related to the traffic congestion in Surabaya City revealed that the factor of traffic volume, roadway capacity, public transportation facilities, and low public awareness were the several causes. Roadway capacity and network also became the main factors of traffic congestion in Medan City according to Lubis (2016). Other research was undertaken by Bergkamp (2011) which mentioned that roadway factor, vehicle factor, and human factor had an influence on the traffic congestion.

Traffic congestion becomes a specter for urban areas as the potential of impact it generates is huge. The impact of traffic congestion as revealed in Santoso (1997), Tamin (2000), Soesilawati (2008), Bharadwaj (2016) were a waste of time, waste of fuel, air pollution, and high accident rate. Ritonga *et al.* (2015) in their research in Manado City conveyed the high cost of transportation operation due to the traffic congestion.

Based on those researches, the researcher formulated hypotheses and model of relationship of several variables (Figure 1) which were indicated to influence the traffic congestion in Bogor City. The hypotheses and model were viewed from the non-technical aspects involving several categories of roadway users with the following hypotheses:

H1a : Behavior of private vehicle drivers had an influence on the traffic congestion of Bogor City

H1b : Ethics of private vehicle drivers had an influence on the traffic congestion of Bogor City

H1c : Behavior of public transportation drivers had an influence on the traffic congestion of Bogor City

H1d : Ethics of public transportation drivers had an influence on the traffic congestion of Bogor City

H1e : Behavior of pedestrians had an influence on the traffic congestion of Bogor City

H1f : Ethics of pedestrians had an influence on the traffic congestion of Bogor City

This traffic problem is in truth generally caused by human factor too as the roadway users. The discipline and legal awareness of roadway users still cannot be said to be good, if they have no compliance and obedience to follow the prevailing rules and laws.

The legal awareness level of the roadway users can be measured from the ability, absorption of each individual, and how it is applied in traffic (Naning, 1982). This is what is called ethics in traffic. Traffic signs are made to provide guidance on what is allowed and which should not be done while driving. The signs are used to state orders that must be carried out by the roadway users (Kansil, 1995).

Meanwhile, behavior in traffic is manifested in actions carried out on roadway. According to Baron and Byrne in Ayuningtyas and Santoso (2007), behavior obedience is a form of social influence which is an individual is asked to do something and the individual does it. An individual obeys an order because the figure who orders it has a certain authority (Deaux *et al*., 1995). Soekanto (1980) explained from the aspect of behavior obedience of roadway

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users, there needs to be a clear sanction and punishment from the authority to the violators of compliance on roadway. These sanctions and punishments are some of the parameters to evaluate the discipline level of a nation, as in extreme terms, it can be measured from the extent to which the community adheres to the traffic laws on roadways (Tabah, 1991; Watanabe, 1995).

There were two objectives of this research to be achieved. First, analyzing the factors that became the sources of traffic congestion based on the perspective of Bogor City's community, viewed from the aspect of behavior and ethics. Second, recommending strategies to control traffic in Bogor City through driving behavior approach. This research did not focus on the technical aspects like infrastructure or road/traffic, but more on the behavior and ethics of roadway facilities' users in Bogor City. This research is expected to be able to help the Government of Bogor City in providing solutions for the occurring traffic hindrance.

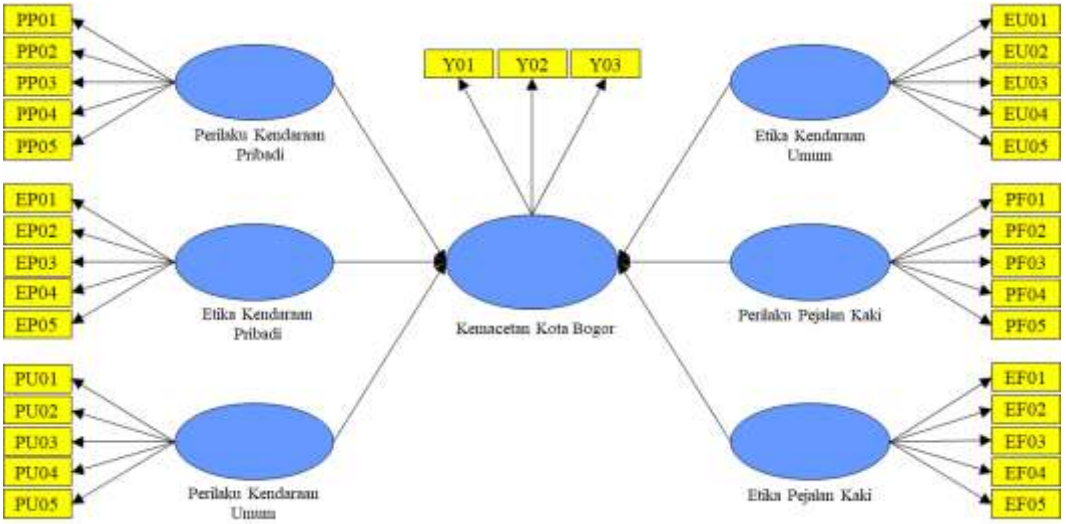

Figure 1. The relationship between variables in the model

Research Methods

This research was conducted in Bogor City by using two types of data collection methods, namely questionnaire and interview. Questionnaires were disseminated to respondents selected through non-probability sampling on three categories of population, namely private vehicle drivers, public transport drivers, and pedestrians. Meanwhile, interview was carried out on Office of Transportation of Bogor City to dig deeper into the phenomena obtained from the questionnaire results. The number of samples used was 70 respondents for each category respectively, so that there were a total of 210 respondents. Quetsionnaire was given directly to the respondent to fill out and return it right after that (at the same time). Using such method, the obtained success ratio of questionnaire collection was 100%.

Partial Least Square (PLS) approach was utilized to analyze the research model. A test with two stages procedure was performed according to Andersen and Gerbing (1988) by testing the measurement model consisting of validity and reliability, then testing the structural model

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to identify the significance of the research hypotheses. Smart PLS version 3.0 was employed to analyze the data.

RESULTS AND DISCUSSION

The model tested further was a model that had been through bootstrapping stage, by excluding several invalid indicators. That model was then tested on its convergent validity. There are at least three parameters to assess whether the model established has a good convergent validity or not, namely factor loadings, composite reliability, and average variance extracted (Hair *et al.,* 2010). According to Hair *et al.* (2010) and Chin *et al*. (1997), the standard value of factor loadings for all indicators is 0.6 at minimum, the standard value of composite reliability is 0.7 at minimum, and the standard value of AVE is 0.5 at minimum.

Table 1. Results of measurement model

Constructs	Indicators	Factor loadings	Composite reliability[a]	AVE[b]
Behavior of Private	PP01	0.733	0.780	0.546
Vehicle Drivers	PP04	0.840		
	PP05	0.627		
Ethics of Private	EP04	0.627	0.859	0.754
Vehicle Drivers	EP05	0.674		
Behavior of Public	PU01	0.747	0.847	0.530
Transport Drivers	PU02	0.547		
	PU03	0.715		
	PU04	0.848		
	PU05	0.748		
Ethics of Public	EU02	0.933	0.838	0.724
Transport Drivers	EU05	0.759		
Behavior of	PF02	0.886	0.812	0.684
Pedestrians	PF03	0.764		
Ethics of Pedestrians	EF01	0.701	0.782	0.546
	EF03	0.684		
	EF05	0.824		
Traffic Congestion of	Y01	0.867	0.833	0.625
Bogor City	Y02	0.726		
	Y03	0.772		

[a] Composite reliability = (square of the summation of factor loadings) / {(square of the summation of factor loadings) + (square of the summation of error variance)}

[b] AVE = (summation of the square of factor loadings) / {(summation of the square of factor loadings) + (summation of error variance)}

The value of factor loadings had met the requirement of exceeding 0.6. The value of composite reliability of each construct variable ranged between 0.780 and 0.859 exceeding the specified limit. The value of AVE of each construct variable ranged between 0.530 and 0.754 also exceeding the specified limit.

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Next, discriminant validity measurement was undertaken by seeing the value of cross loading of each variable. This parameter was determined by comparing the correlation between construct and the square root of AVE of the construct.

Table 2. Discriminant validity of the constructs[a]

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1)	Ethics of Private Vehicle Drivers	**0.868**						
(2)	Ethics of Public Transport Drivers	-0.114	**0.851**					
(3)	Ethics of Pedestrians	-0.015	0.215	**0.739**				
(4)	Traffic Congestion of Bogor City	-0.073	0.145	0.096	**0.791**			
(5)	Behavior of Private Vehicle Drivers	-0.193	-0.051	0.135	0.144	**0.739**		
(6)	Behavior of Public Transport Drivers	-0.432	0.307	0.059	0.372	0.103	**0.728**	
(7)	Behavior of Pedestrians	0.072	-0.037	-0.377	0.100	-0.120	-0.135	**0.827**

[a] Diagonal value shows the square root of AVE, while others show the correlation value between constructs

From Table 1 and 2, it can be concluded that in general, the model had sufficiently met the requirement of convergent validity and discriminant validity.

Reliability analysis was then conducted to find out how consistent an instrument measures the measured concept. The recommended value is more than 0.6. Table 3 shows that all values of alpha were more than 0.6. It can be concluded that the measurement of model was reliable.

Table 3. Results of reliability test

Construct	Alpha Cronbach	Number of indicators[a]
Behavior of Private Vehicle Drivers	0.780	3 (5)
Ethics of Private Vehicle Drivers	0.859	2 (5)
Behavior of Public Transport Drivers	0.847	5 (5)
Ethics of Public Transport Drivers	0.838	2 (5)
Behavior of Pedestrians	0.812	2 (5)
Ethics of Pedestrians	0.782	3 (5)
Traffic Congestion of Bogor City	0.833	3 (3)

[a] Final number of indicators (initial number of indicators)

Furthermore, the value of R^2 and path analysis were viewed which indicate how good the data were in supporting the proposed hypotheses. R^2 is also used to see the extent to which the exogenous variables were able to explain the variability of its endogenous variable. Table 4 and Figure 2 portray the PLS structural model. Ethics of private vehicle drivers ($\beta = 0.126$,

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$p < 0.05$), ethics of pedestrians (β = 0.132, $p < 0.05$), behavior of private vehicle drivers (β = 0.133, $p < 0.05$), behavior of public transport drivers (β = 0.429, $p < 0.05$), and behavior of pedestrians (β = 0.216, $p < 0.05$) explained 20.6% variability of traffic congestion of Bogor City. Those results support the hypothesis H1a, H1c, H1d, H1e, and H1f, but reject the hypothesis H1b.

Table 4. Summary of structural model

Relationships	Hypotheses	Path coefficient	t-value	Results
Ethics of Private Vehicle Driver -> Traffic Congestion of Bogor City	H1a	0.126*	2.312	Supporting
Ethics of Public Transport Drivers -> Traffic Congestion of Bogor City	H1b	0.014	0.502	Not supporting
Ethics of Pedestrians -> Traffic Congestion of Bogor City	H1c	0.132*	2.632	Supporting
Behavior of Private Vehicle Drivers -> Traffic Congestion of Bogor City	H1d	0.133*	2.103	Supporting
Behavior of Public Transport Drivers -> Traffic Congestion of Bogor City	H1e	0.429**	7.837	Supporting
Behavior of Pedestrians -> Traffic Congestion of Bogor City	H1f	0.216*	3.183	Supporting

** $p \leq 0.01$, * $p \leq 0.05$

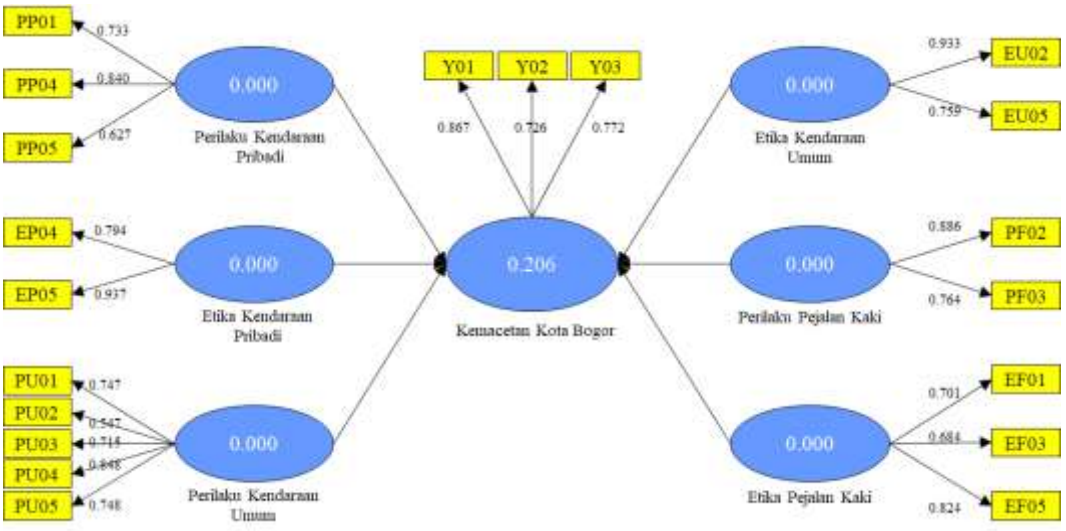

Figure 2. Structural model

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This research was conducted using different approach, to analyze the relationships of variables in traffic congestion phenomenon, compared to other researches which usually put more emphasis on the technical aspects like facilities and infrastructure. The variables involved were analyzed in explorative manners with limited literatures which specially discuss about traffic congestion viewed from non-technical aspects (ethics and behavior). Several previous researches like Bergkamp (2011), Rozari and Wibowo (2015), and Mustikarani and Suherdiyanto (2016), did not focus on non-technical aspects as there were technical variables in their research.

In general, the result of this research, as expected before, was that ethics and behavior of people who became the samples, had an impact on traffic congestion in Bogor City. This is in accordance with the result of interview with Office of Transportation of Bogor City. Behavior aspect from all the three categories of respondent had a significant influence which in fact can be seen from the doubtful decision to turn, lacking awareness on route and speed, stopping vehicles arbitrarily, and crossing road on the wrong place. Ethics aspect from private vehicle drivers and pedestrians also had a significant influence on traffic congestion which can be seen from the violation of traffic signs and lack of monitoring and sanctions from the authority.

The interesting thing is that behavior of public transport drivers turned out to have no significant impact on traffic congestion in Bogor City, not as expected before. This is most likely because public transport drivers had been knowing the traffic signs and regulations on roadway.

Implication to Research and Practice

This research also gave an indication that the Government of Bogor City through Office of Transportation can coordinate with the Police to enhance the order on roadway through educational programs, assignment of officers at vulnerable points, and giving strict deterrent effect for traffic violators, including pedestrians. Providing road marks in the form of travel time estimation is also important for roadway users.

CONCLUSION

The factors causing traffic congestion do not only come from the lack of facilities and infrastructure, but also come from the behavior of roadway users. Therefore, it is important for decision makers to not only focus on technical aspects (road widening, installation of signs, traffic engineering) as solutions to reduce traffic congestion, but to start paying attention to non-technical solutions which touch the roadway users. As confirmed by this research, ethics and behavior of private vehicle drivers, ethics and behavior of pedestrians, and ethics of public transport drivers had a significant impact on traffic congestion of Bogor City. These findings are in line with the expectation and previous researches indicating the presence of non-technical factors as the causes of traffic congestion.

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APPENDIX

Behavior of Private Vehicle Drivers

PP01	Driving the vehicle at law speed when the traffic flow is smooth
PP04	Slow at making decision in driving (to turn/overtake)
PP05	Passing not on the designated lane

Ethics of Private Vehicle Drivers

EP04	Driving against the flow of traffic/vehicles with the goal of saving time
EP05	Knowing and fearing the punishment from acts of traffic violation

Behavior of Public Transport Drivers

PU01	Driving the vehicle at law speed when the traffic flow is smooth
PU02	Stopping (to get some passengers) anywhere although breaking the rules
PU03	Stopping the vehicle anywhere according to the passenger's instruction
PU04	Overtaking vehicle from any direction
PU05	Passing not on the designated lane

Ethics of Public Transport Drivers

EU02	Ignoring the traffic signs because there are no officers monitoring
EU05	Knowing and fearing the punishment from acts of traffic violation

Behavior of Pedestrians

PF02	Crossing by using zebra cross/crossing bridge
PF03	Hopping on to vehicle anywhere without seeing the traffic signs

Ethics of Pedestrians

EF01	Knowing the meanings of traffic signs, but ignoring them
EF03	Ignoring the signal from the vehicles when crossing although in the right place
EF05	Fearing the punishment from acts of traffic violation

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