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BINARY LOGISTIC REGRESSION MODELING OF MOTORCYCLE RIDER BEHAVIOR ON THE IMPLEMENTATION OF ELECTRONIC TRAFFIC LAW ENFORCEMENT IN PADANG CITY

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Abstract

Traffic violations by motorcyclists remain a persistent problem in Indonesian cities. Padang City officially implemented an Electronic Ticketing (ETLE) system on March 23, 2021, at five priority intersections. However, violations continued to occur, indicating that the system's presence alone has not been sufficient to change motorcyclist behavior. This study aims to: 1) determine the characteristics of violations at five ETLE locations in Padang City, 2) identify factors that influence motorcyclist behavior toward ETLE implementation, and 3) obtain a binary logistic regression equation model for analyzing motorcyclist behavior toward ETLE implementation. Data were collected through observation, interviews, questionnaires, and documentation from 400 respondents (80 per location). Descriptive and binary logistic regression analyses were applied. Results show that violators were predominantly female, aged over 17 years, held a Class C driving license for more than five years, did not take the practical exam to obtain it, were in less stable emotional conditions, had never received ETLE socialization, and had never received an electronic ticket sanction. Binary logistic analysis identified two significant factors: the length of time to obtain a Class C driving license (X1) and whether the respondent took the theory/practical exam (X2), with a combined influence of 32.3% on ETLE compliance (Nagelkerke $R^2 = 0.323$). The resulting regression model is: $Y = -1.137 + 1.502X1 + 1.738X2$. These findings suggest that licensing quality and driver education are key levers for improving compliance with electronic traffic enforcement systems.

Keywords: *Electronic ticketing, driver behavior, regression, binary logistics*

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INTRODUCTION

Transportation plays a fundamental role in supporting economic activities, social interactions, and regional development. In Indonesia, the rapid growth of urbanization and motorization has significantly increased the demand for transportation services, particularly the use of private vehicles [1-2]. Motorcycles have become the dominant mode of transport due to their affordability, flexibility, and ability to navigate congested urban roads. However, the rapid

increase in vehicle ownership has also been accompanied by a growing number of traffic violations and road safety problems. Many road users continue to disregard traffic regulations, resulting in behaviors that endanger both themselves and other road users. Traffic violations, such as failing to wear helmets, running red lights, driving against the traffic flow, and using mobile phones while driving, remain common despite continuous law enforcement efforts [3-4].

To improve road safety and strengthen traffic law enforcement, the Government of Indonesia introduced the **Electronic Traffic Law Enforcement (ETLE)** system as part of the modernization of traffic management. Following the directive of the President of the Republic of Indonesia, the Indonesian National Police initiated the nationwide implementation of electronic traffic enforcement in early 2016 [5-6]. Unlike conventional ticketing systems that rely on direct interaction between police officers and offenders, ETLE utilizes closed-circuit television (CCTV) cameras integrated with automatic vehicle identification technology to detect traffic violations and issue electronic citations. This technology-based enforcement system is expected to improve transparency, reduce opportunities for corruption, enhance law enforcement efficiency, and ultimately encourage greater compliance with traffic regulations [3, 7].

Jakarta became the first city in Indonesia to fully implement the ETLE system in November 2018 by installing surveillance cameras at twelve strategic intersections. Within the first week of implementation, the system successfully recorded 62 traffic violations, demonstrating its capability to detect offenses effectively and consistently [8]. The successful implementation in Jakarta subsequently encouraged the gradual expansion of ETLE to other major cities throughout Indonesia as part of the national strategy to improve road safety and traffic discipline.

Padang City, the capital of West Sumatra Province, serves as the administrative, commercial, educational, and healthcare center of the region. These functions have contributed to rapid urban growth and a continuous increase in traffic volume, particularly involving motorcycles. According to the Padang City Police, a total of 29,868 traffic violations were recorded between January and November 2018, representing an increase compared with the previous year [9]. Approximately 70% of these violations involved motorcycles, with the most frequent offenses including failure to wear safety helmets, driving against the direction of traffic, and other equipment-related violations. These statistics indicate that motorcycle riders constitute the largest contributor to traffic violations in Padang City and therefore represent an important target group for traffic safety interventions.

To address this issue, the Padang City Transportation Agency officially implemented the ETLE system on March 23, 2021, at five priority intersections, namely the Masjid Raya Sumbar Intersection, Jenderal Sudirman Intersection, Bank Indonesia Intersection, Kandang Intersection, and the Bgd. Aziz Chan–Moh. Yamin–Proklamasi Intersection. During only the first two weeks of operation, from March 23 to April 6, 2021, the ETLE system recorded 955 traffic violations [10]. The system monitors seven categories of traffic offenses, including failure to wear a helmet, failure to use a seat belt, using a mobile phone while driving, making illegal U-turns, running red lights, violating road signs or pavement markings, and driving against the traffic flow. These findings suggest that although ETLE has strengthened traffic monitoring and enforcement, traffic violations continue to occur at relatively high frequencies.

Previous studies have generally focused on evaluating the technical implementation of ETLE, its legal framework, and its effectiveness in reducing traffic violations [11-12]. However, relatively limited attention has been given to understanding the behavioral factors that influence motorists' compliance with electronic traffic enforcement, particularly among motorcycle riders who account for the majority of traffic violations in Indonesian cities.

Since compliance with traffic regulations is influenced not only by law enforcement but also by individual characteristics, perceptions, knowledge, and attitudes toward ETLE, identifying these behavioral determinants is essential for improving the effectiveness of electronic enforcement policies. An empirical investigation of these factors can provide valuable evidence for designing more targeted traffic safety programs and public awareness campaigns.

Therefore, this study aims to analyze the characteristics of traffic violations at the five ETLE monitoring locations in Padang City and to identify the factors that significantly influence motorcyclists' compliance behavior under the ETLE system. Specifically, this research addresses three questions: (1) What are the characteristics of traffic violations at the five ETLE locations in Padang City? (2) Which factors significantly influence motorcyclists' behavior toward ETLE implementation? and (3) What binary logistic regression model best explains the relationship between these factors and compliance with ETLE regulations? By applying binary logistic regression analysis to empirical survey data, this study is expected to contribute to a better understanding of motorcyclists' behavioral responses to electronic traffic enforcement and to provide evidence-based recommendations for enhancing traffic law enforcement and road safety policies in Indonesia.

RESEARCH METHODOLOGY

Research Location

The research location for the completion of this final assignment was carried out at 5 (five) points. For more clarity, each research location can be seen in the Figure. The first location is the Masjid Raya Sumbar intersection (Figure 1), the second location is the intersection of Jl. Jendral Sudirman (Figure 2), the third location is the Bank Indonesia intersection (Figure 3), the fourth location is the Kandang intersection (Figure 4), the fifth location is the intersection of Jl. Bgd Aziz Chan-Moh. Yamin-Jl. Proklamasi (Figure 5).

Figure 1. West Sumatra Grand Mosque Intersection

Figure 2. Jl. Jenderal Sudirman Intersection

Figure 3. Bank Indonesia Intersection

Figure 4. Kandang Intersection

Figure 5. Intersection of Jalan Bgd Aziz Chan-Moh. Yamin-Jl. Proklamasi

Respondent Criteria and Sampling

Questionnaires were distributed to motorcyclists passing through each of the five research locations. To ensure relevance to the study objectives, respondents were screened prior to questionnaire distribution. Only motorcyclists who admitted to having committed at least one traffic violation — whether or not captured by the ETLE cameras — were included as valid respondents. Motorcyclists who stated they had never committed any violation were excluded from the sample. This screening was conducted verbally by the researcher before handing over the questionnaire. A total of 400 valid respondents were obtained, with 80 respondents at each location.

Data Analysis Techniques

Descriptive Analysis Method

Eighty questionnaires will be distributed at each research location. These questionnaire forms will be distributed to motorcyclists/respondents passing through the location. This descriptive analysis will be conducted on each variable/question in the questionnaire. The results of this questionnaire data will be illustrated in a diagram. This diagram will then show the percentage of each question in the questionnaire. Secondary data, in the form of the number of electronic ticketing violations from April 2021 to July 2021, will also be depicted in graph form. This graph will then show the increase and decrease in the number of violations.

Logistic Regression Analysis

In logistic regression analysis, a predictive model is created, similar to linear regression. The difference lies in the dependent variable. In logistic regression, researchers predict a dichotomous dependent variable. There are several steps involved in analyzing a logistic regression model [10].

- Logistic Regression Model Feasibility Test

  To obtain the best logistic regression model, an analysis will be carried out of all the possibilities that can be formed from the independent variables against the dependent variable.

- Formulating Logit Model Estimates

  First step is determining the dependent variable (Y). The dependent variable in this final project research is the implementation of electronic ticketing. Where, Y is Implementation of electronic ticketing. There are two indicators in this variable, which are distinguished as follows:

  Y = 1, if the respondent selects "appropriate"

  Y = 0, if the respondent selects "not appropriate"

  Second step is determining the Independent Variable (X). The independent variable in this study is driver behavior. The factors influencing the dependent variable (Y) are the length of time it took to obtain a Class C driver's license (X1) and the time taken to obtain the class C driver's license (X2).

  The third step is determining the parameters of the logistic regression model. The parameters for the logistic regression model in this study were determined using SPSS software and tested for model suitability.

  The fourth step is significance test for all variables. Test the significance of the overall influence of the independent variables (X) on the dependent variable (Y) using the G-test. To determine whether the independent variables are significant simultaneously or as a whole, a test is conducted on the hypotheses discussed in the theoretical framework.

  The last step is testing the significance of each variable. Test the significance of the influence of each independent variable on the dependent variable using the Wald test. To determine the significance of each independent variable parameter, the hypotheses discussed in the theoretical framework are tested. Formulating a logit model estimate and obtained using the formula:

$$\pi\,(X) = \frac{\exp(\beta_0 + \beta_1\ X_1 + \ldots + \beta_p\ X\,p}{1+\exp(\,\beta_0 + \beta_1\ X_1 + \cdots + \beta_p\ X\,p)} \qquad (1)$$

  where each parameter has the following description:

π(X)	=	The probability that the event of interest occurs, given the predictor variables X. Its value ranges from **0 to 1**.
β0	=	**Intercept (constant)**. This is the log-odds of the event when all predictor variables are equal to zero.
β1,β2,…,βp	=	**Regression coefficients**. Each coefficient measures the effect of its corresponding predictor variable on the log-odds of the outcome.
X1,X2,…,Xp	=	**Independent (predictor) variables** used to explain or predict the outcome. Examples include age, income, education, speed, helmet use, etc.
p	=	The total number of predictor variables included in the model.

RESULT AND DISCUSSION

Characteristics of Violations

The descriptive analysis presented the profiles of respondents who committed violations across the five ETLE locations. The dominant characteristics were: female gender (50.25%), age over 17 years (68.75%), Class C driving license held for more than five years (56.25%), obtained without taking the practical exam (61.00%), less stable emotional condition at the time of violation (52.75%), no prior socialization about ETLE (72.00%), no knowledge of ETLE camera locations (66.75%), and no prior experience of receiving an electronic ticket sanction (73.00%).

In terms of violation frequency, 29.25% of respondents reported committing one violation in the previous month, while 24.00% reported committing more than three violations. Regarding violation types, the ETLE system in Padang City predominantly captured violations related to not wearing a helmet, riding against traffic flow, and violating traffic lights — consistent with the violation categories described in the Introduction.

These findings indicate that the majority of violators are experienced riders (holding a license for over five years) who obtained their license without proper examination, suggesting that the formal licensing process does not effectively instill traffic discipline. The low level of ETLE awareness further reinforces the need for broader public socialization campaigns

Factors Influencing Motorcyclist Behavior

The binary logistic analysis identified two variables with a statistically significant influence on ETLE compliance: the length of time to obtain a Class C driving license (X1) and whether the respondent took the theory/practical exam for the Class C license (X2). Both variables yielded a Sig. value of 0.000, which is below the alpha threshold of 0.05, confirming their significance.

The Nagelkerke R^2 value of 0.323 indicates that these two variables together explain 32.3% of the variation in respondents' compliance behavior toward the ETLE system. The remaining 67.7% is attributed to other variables not examined in this study, such as law enforcement intensity, peer influence, road infrastructure conditions, or individual risk perception.

It is important to note that the dependent variable (Y) in this analysis reflects whether respondents considered the electronic ticket sanctions appropriate for the violations committed — which serves as a behavioral proxy for compliance attitude. Respondents who perceived the sanctions as appropriate tended to be those with proper licensing backgrounds, suggesting that formal driver education contributes positively to acceptance of traffic enforcement systems.

Binary Logistic Regression Model

The binary logistic regression model obtained through the Wald test is as follows:

$$Y = -1.137 + 1.502X1 + 1.738X2 + \mu \quad (2)$$

The constant value of −1.137 indicates that, in the absence of both independent variables (i.e., a rider with a recently obtained license who did take the exam), the log-odds of perceiving the ETLE sanctions as appropriate is negative, meaning non-compliance attitude is more likely.

The coefficient of X1 (1.502) means that motorcyclists who have held a Class C driving license for more than five years have significantly higher log-odds of perceiving ETLE sanctions as appropriate compared to those who obtained their license more recently. This may reflect greater accumulated road experience, though it also coincides with a higher violation rate — suggesting that experience alone does not guarantee compliance without proper initial training.

The coefficient of X2 (1.738) is the largest in the model, indicating that whether or not a respondent took the theory/practical exam has the strongest influence on compliance attitude. Riders who went through the formal exam process showed greater acceptance of traffic enforcement measures, underscoring the importance of a rigorous and standardized licensing system in shaping law-abiding road behavior.

CONCLUSION

Based on the research conducted, the following conclusions are drawn:

- The characteristics of motorcyclists who committed violations at the five ETLE locations in Padang City were predominantly female, aged over 17 years, holding a Class C driving license for more than five years obtained without a practical exam, in less stable emotional conditions, having never received ETLE socialization, unaware of ETLE camera locations, and having never received an electronic ticket sanction. The most frequently occurring violation types included not wearing a helmet, riding against traffic flow, and violating traffic lights.
- Two factors were found to significantly influence motorcyclist behavior toward ETLE implementation: the length of time to obtain a Class C driving license (X1) and whether the respondent took the theory/practical exam (X2). Together, these variables explain 32.3% of the variation in compliance attitude, while the remaining 67.7% is attributed to other variables not examined in this study.
- The binary logistic regression model obtained is: $Y = -1.137 + 1.502X1 + 1.738X2 + \mu$. This model indicates that both the duration of licensing and the quality of the licensing process — particularly whether proper examinations were undertaken — are significant predictors of a motorcyclist's attitude toward electronic traffic enforcement. These findings suggest that strengthening the driving license examination system and expanding public socialization of the ETLE program are key policy recommendations to improve traffic compliance in Padang City.

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