A CONFIRMATORY FACTOR ANALYSIS OF ACCIDENTS CAUSED BY THE MOTORCYCLE ASPECT IN URBAN AREA

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Abstract: Traffic safety should be given the highest priority in order to reduce accidents. It seems that motorcycles give the most contribution to accidents than other vehicles, especially in urban area. The accidents are caused by poor condition factors of the motorcycles. Therefore, it is important to know the motorcycle aspect as a base to implement an action program to reduce accident risks. The objectives of this research were to analyze motorcycle aspect on accident risks including tires, brakes, lamps, engines, chassis, mirrors, conspicuity, and equipments for riding. This was a perceptional research where the victims are as respondents, and questionnaire forms were given to 50 respondents. The method of analysis used in this research was Confirmatory Factor Analysis. Results of this research indicate that tires, brakes and equipments, did not give significant influence on factors causing the accidents. However, the other variables namely lamps, engines, chassis, mirrors and conspicuity gave significant influence on traffic accident risks. Final modeling results that were obtained showed that the factors that cause motorcycle accidents are the following: lamps, engine, chassis, mirrors, and conspicuity.

Keywords: traffic safety, accidents cause, motorcycle, confirmatory factor analysis, urban area.

1. Introduction

The condition of traffic safety in Indonesia is an issue that is still not given enough attention. This is based on facts that the level of accidents in highways in Indonesia is still high. According to the Directorate of Land Transportation Safety – General Directorate of Land Transportation (2006), 26.211 people died in Indonesia in 2003 due to road traffic accidents. Proportionally, motorcycle vehicle contributed greatly to the scene of the accident. The reason of this problem lies mainly in the fact that population of motorcycle owners in Indonesia is growing fast. In 2003 the number of motorcycles reached 23.3 million vehicles, and it was estimated that in late 2010 the number would reach over 45 million vehicles. Meanwhile, traffic awareness is still low and the handling of issues by stakeholders accident liability are still not in line with expectations. This has exacerbated the problem of traffic safety, especially in relation to highway motorcycles (Lubis, 2008; Departemen Perhubungan RI, 2007).

Basically, motorcycle accidents can be caused by various factors, including humans, vehicles, roads and environment. The cause of the accident can be influenced by just one factor or a combination of various factors that are interrelated. As shown in the research done by

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Sulistio et al. (2006), which was conducted at the crossroads in urban areas in Malaysia, it is stated that motorcycle accidents are influenced by traffic volume, speed, road shoulders, the number of lanes, and environmental conditions. Similar research was also conducted by Suraji and Sulistio (2009) with a shot in Malang, East Java. In addition, Hussain et al. (2005) and Suraji and Sulistio (2010) also have examined the dynamic space requirements for motorcycles in connection with the design of exlusive motorcycle lanes. Some research has been done by Suraji et al. (2010) on the role of a driver in causing the accidents. The research was conducted in the city of Malang, East Java. The results of studies, using Structural Equation Modeling (SEM) analysis methods, showed that there are interrelations among variables causing accidents.

According to Ogden (1996), the vehicle is one of the factors that cause accidents. Motorcycle consists of several components, such as: tires, brakes, lamp, engine, chassis, mirror, conspicuity, and driving equipment. Maintaining these components in good condition is very important for reducing the risk of accident. Failure in one component may cause and trigger the occurrence of accidents. Unfortunately, motorcycle owners are not fully aware of this issue, and many of them do not keep their vehicles in a proper condition. In fact, not all motorists are fully aware that when there is one motorcycle component that is not working, it could pose a risk of accidents. It is very important to analyze the influence of each component on the vehicle, in order to identify the main causing factors of the accidents. With these efforts, the safety performance of motorcycle traffic in particular can even be better realized.

The Government of Indonesia is determined to achieve a better traffic safety for all traffic users by conducting variety of strategies, policies, action programs and other appropriate measures. The Road user safety campaign is also a flagship program for reducing the number of accidents (Undang Undang RI, 2009; Peraturan Menteri Perhubungan, 2006).

The Directorate of Land Transport Safety of the Republic of Indonesia (RI) launched a program, named "Road Safety For All", which purpose is to increase road safety. All road users (pedestrians, vehicles, public transport and patrolmen) are obliged to keep the traffic safety at the highest possible level, so the awareness of traffic situation could be constantly maintained (Direktorat Keselamatan Transportasi Darat-Ditjen Hubdat, 2006).

The Objective of this research is to determine the effect of motorcycle components on the risk of traffic accidents. As it has been already mentioned, motorcycle components are: tires, brakes, lamp, engine, chassis, mirror, conspicuity, and motorcycle riding equipment.

2. Research Methods

2.1. Conceptual Framework

This research was contructed on the basis of the following conceptual framework. Motorcycle accidents may be influenced by various factors among others humans, vehicles, roads, environments. Concerning with motorcycle aspects, it is assumed that such accidents are influenced by eight variables, namely tires, brakes, lamps, engine, chassis, mirrors, conspicuity and equipments. An illustration of the main components of a motorcycle related to accidents can be seen in Fig. 1.

The eight variables directly influence the motorcycle accidents. The motorcycle accidents are endogenous variables while

Fig. 1.
The Main Components of a Motorcycle
Source: Author

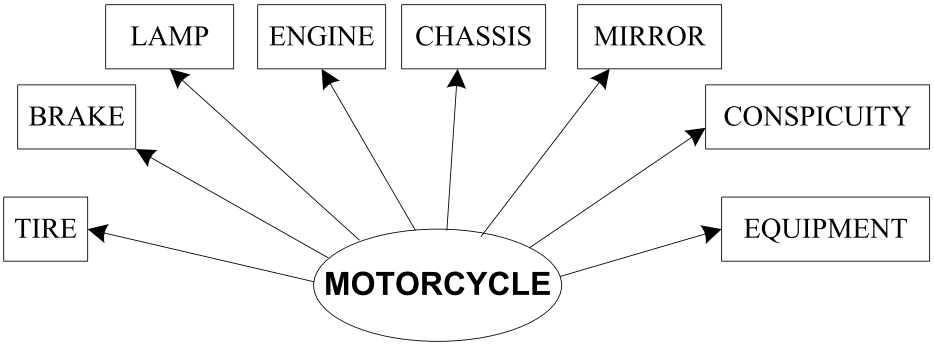

Fig. 2.
Conceptual Framework for Research
Source: Author

the eight variabels are exogenous ones. The endogenous variables are predicted from the exogenous variables. The motorcycle varable are the latent ones (unobserved variables) while the eight variables are the observed variables. Schematically, the structure of the conceptual framework of relationships among variables can be seen in Fig. 2.

2.2. Data Collection Techniques

This is a type of research in which a user opinion of motorcycle accident acts as the main respondent. However, to complete the questionnaire items, an accident scene witness, a close friend, or close relatives may be asked for additional information. Respondents who were selected randomly are located in various public places such as campuses, terminals, public refueling stations, shopping centers, etc. The number of respondents taken was 50 persons with the research site in the city area of Blitar, East Java. In the questionnaire, each variable was made up of a variety of questionnaires according to the context variables. Respondents chose answers that correspond to the attitudes and perceptions held. The answer is available in a choice graded (Likert scale 1-5) ranging from not at all, not enough, enough, over enough and very much. Score 1 means less likely to have contributed to the occurrence of the risk of accidents, while the score 5 means that there is a tendency to have contributed to the occurrence of the risk of accidents.

2.3. Method of Analysis

To determine the influence of vehicle factors on the risk of traffic accidents Factor Analysis Method (FAM) was used. Several factors are included in the factor of the vehicle namely: tires, brakes, lamp, engine, chassis, mirror, conspicuity, and motorcycle riding equipment. Relationships built among several of these factors influence the inter-connections and the independent and dependent variables. To test the close relationship between the variables, an analytical tool of KMO (Kaiser Meyer Olkin) was employed, where the proximity of the sample can be determined from the value of KMO located from 0.5 to 0.75. KMO is a coefficient explaning the level of relationship adequacy of all variables. Next, to find out correlation between variables and factor analysis, the MSA (Measures of Sampling Adequacy) was used. The MSA explains an indicator of the relationship adequacy but it is calculated for every variable attribute in the factor analysis. The MSA value on each variable is used to determine the relationship between variables as a condition of FAM. MSA is used to measure the correlational relationship of two variables involved in the factor analysis and the relationship of each variable on the feasibility. MSA values above 0.5 either together or separately is an indication of the feasibility of the existing boundary.

3. Results and Discussion

3.1. Test Results and Statistics

From the results of data processing, as shown in Table 1, a validity test at a significance level (Significance = 0.01, see the sign **) is obtained on almost all factors except the variable BRAKE and EQUIPMENT. The result of the reliability test obtained by Cronbach's Alpha is 0.713 and it is greater than the Alpha table which is 0.279. Thus it can be said that the research data is valid and reliable enough to be used for further processing stages.

Table 1
Results of Test Validity of Each Variable

Variabel	Person Correlation	Significance (0.01)
TIRE	0.628**	Correlation significant
BRAKE	0.237	Correlation is not significant
LAMP	0.700**	Correlation significant
ENGINE	0.717**	Correlation significant
CHASSIS	0.482**	Correlation significant
MIRROR	0.645**	Correlation significant
CONSPICUITY	0.563**	Correlation significant
EQUIPMENT	0.255	Correlation is not significant

Source: Author

Table 2
Results of Measures of Sampling Adequacy (MSA)

Variable	Value of Anti-image matrices (MSA)	Cut off value	Description
TIRE	0.521 a	0.5	Marginal
BRAKE	0.507 a	0.5	Marginal
LAMP	0.746 a	0.5	Significant
ENGINE	0.745 a	0.5	Significant
CHASSIS	0.773 a	0.5	Significant
MIRROR	0.636 a	0.5	Significant
CONSPICUITY	0.666 a	0.5	Significant
EQUIPMENT	0.368 a	0.5	Not Significant

Source: Author

3.2. Factor Analysis

Factor analysis in this research use the type of analysis which is based on KMO and MSA. Initially, the eight variables were tested. The results of statistical analysis showed that the KMO value is 0.644. From these results, it can be seen that the sample was acceptable for use, considering that KMO value is between 0.5 and 0.75. Thus, based on the condition, the data can be used for subsequent analysis.

Furthermore, an analysis of the factors is used to assess the functioning MSA linkages among variables. MSA is used to measure the correlational relationship between two variables involved in the factor analysis, and the relationship among each variable. MSA values above 0.5, either together or separately, are indicators that the minimum threshold for eligibility is being reached.

The calculation results using the AMOS program, the results of the Anti-image matrices and the contribution of each variable on the risk of traffic accidents are shown in Table 2. The results of factor analysis showed that the variables TIRE and BRAKE contribute marginally to the occurrence of accidents, since the Anti-image matrices are close to 0.5. On the other hand, EQUIPMENT variable doesn't have significant influence, while the variables LAMP, ENGINE, CHASSIS, MIRROR, and CONSPICUITY contribute significantly to the occurrence of accidents having the Anti-image matrices for all variables above 0.5.

In order to increase the feasibility of the model, it had been tested several times. By modifying values indexes, the model structure is shown in Fig. 3. At this stage Regression Weights for all variabels with the value of the $p \leq 0.01$ (Table 3) are produced.

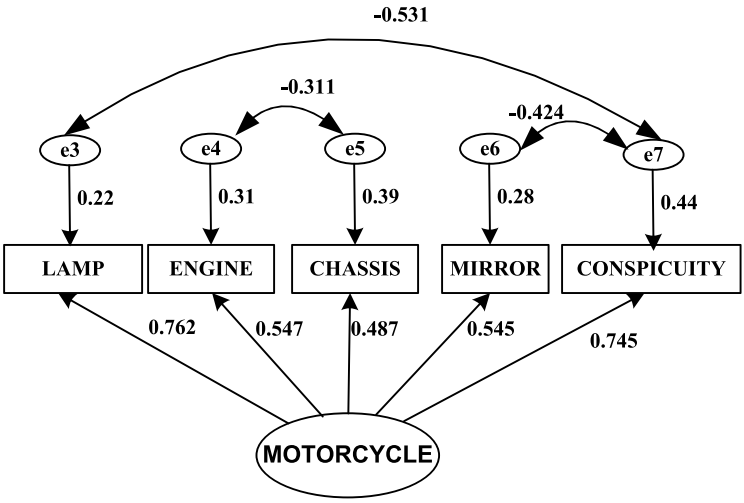

Fig. 3.
Mesurement Model–Confirmatory Factor Analysis for Final Model
Source: Author

It can also be seen that the Critical Ratio is identical to the t-test, as all the coefficients on each variable are zero. Thus, the null hypothesis is rejected and the hypothesis in which exists causal relationships in the model is accepted. Based on Table 4, the Goodness of Fit Index which includes the Chi-Square, Significance Probability, GFI, AGFI, CMIN/DF, TLI, and CFI showed that all parameters in the modeling successfully met the cut-off value. This means that the criteria have met parameters required to produce a reliable model.

Value Standardized Regression Weights (loading factor) of this phase also result in selecting six indicators in total. All six indicators have an Estimate (loading factor) more than 0.4 which is shown in Table 5. Therefore, the modeling of these 6 indicators can be used to explain the factors of motorcycle. Smoothing modeling to produce the final model was also done by creating an index modification. Modification indices were compiled by making the covariance between the error, and they are as follows: e3-e7, e4-e5, e6-e7. Thus, the results of this stage can be said to be feasible as a result of the final modeling.

The result of the Final modeling can already be considered worthy, since it shows that there are variabels that can be grouped into two categories based on the regression weights, namely:

1) Variable LAMP and the value of regression weights CONSPICUITY are 0.762 and 0.745 respectively, and they have the most significant contribution, compared with other variables, on the motorcycle accidents.

2) Variables ENGINE, CHASSIS, and MIRROR with the regression weights of less than 0.6 have a significant contribution, but the lowest compared with other variables.

Table 3

Regression Weights for Final Model

Variable	Direction of Affecting	Factor	Estimate	P-value	Description
LAMP	<---	MOTORCYCLE	0.278	0.000	Significant
ENGINE	<---	MOTORCYCLE	0.746	0.000	Significant
CHASSIS	<---	MOTORCYCLE	0.956	0.000	Significant
MIRROR	<---	MOTORCYCLE	0.935	0.000	Significant
CONSPICUITY	<---	MOTORCYCLE	0.591	0.000	Significant

Source: Author

Table 4

Goodness of Fit Index for Final Model

No	Parameter	Cut-off Value	Result	Description
1	Chi-square	≤11.7	7.512	Good
2	Probability	³ 0.05	0.147	Good
3	RMSEA	£ 0.08	0.065	Good
4	GFI	³ 0.90	0.983	Good
5	AGFI	³ 0.90	0.943	Good
6	CMIN/DF	£ 2.00	1.635	Good
7	TLI	³ 0.95	0.881	Marginal
8	CFI	³ 0.94	0.951	Good

Source: Author

Table 5

Standardized Regression Weight for Final Model

Variable	Direction of Affecting	Factor	Estimate	Recomendation
LAMP	<---	MOTORCYCLE	0.762	Used
ENGINE	<---	MOTORCYCLE	0.547	Used
CHASSIS	<---	MOTORCYCLE	0.487	Used
MIRROR	<---	MOTORCYCLE	0.545	Used
CONSPICUITY	<---	MOTORCYCLE	0.745	Used

Note: Cut of Value for Loading Factor > 0.4

Source: Author

3.3. Discussion

The results of this research indicate that the tires, brakes and equipments variables relatively had no effect on crash. This could be explained by general good condition of the tires and brakes, so they can't cause the accidents. These results differ from previous research results. This phenomenon is different from the results of a research which reviews the effect of speed on accidents. According to these results, a high speed can potentially lead to accidents if the tires and brakes are not reliable enough, or if they are not accompanied by the ability of a skilled rider. (Liu et al. 2005; Mitsopoulos et al. 2005).

This research's findings show that there are five variables that affect a motorcycle accident namely lamps, engine, chassis, mirrors and conspicuity. For light and conspicuity variables, the results of this research is in line with the findings of Radin Umar et al. (1996) which states that conspicuity is good, if the lights are turned on during the day, thus reducing the risk of motorcycle accidents by 29%. The program of the Indonesian government is stated in the regulation which stipulates that motorists are required to turn on the lights during the day. This regulation is also expected to be able to decrease the number of motorcycle accidents (Undang Undang RI, 2009).

The condition of the engine and chassis has a significant effect on a motorcycle accident. This is in accordance with the opinion of MVA (2008) which is closely related to the ability to balance acceleration and motorcycles. Engine conditions that are poorer or that are modified to produce higher capacities, and the disproportional and unbalanced condition of the chassis may have the potential for accidents. A large number of the motorcycles owners are young children, who maintain their vehicles on their own. This leads to a poor condition of the motorcycles, and thus also to a low traffic safety. Mirror serves to determine the presence of vehicles in the back so riders are able to anticipate when the motorcycle will be maneuvered. The results of this research indicate that with the presence of mirrors the risk of accidents can be reduced. However, in accordance with the recommendation from MVA (2008), the installation of the new mirror is considered effective with the two mirrors, either on the right or left, installed perfectly.

Equipment does not affect the motorcycle accidents. The equipment, like helmets, jackets, shoes, gloves etc., is necessary to reduce the risk of injury. This result is also in line with by the MVA (2008) that defines the procedures for the operation of a motorcycle on the highway.

The Final modeling which was obtained showed that the factors that cause motorcycle accidents are the following variables: lamp, engine, chassis, mirrors, and conspicuity. It can be seen from the results of regression weight (loading factor) that it has significant value for all variables. The tires, brakes and equipments variables are not the factors that contribute to motorcycle accidents.

4. Conclusion

The results of this research can be summarized as follows:

1) Condition of motorcycle tires, brakes and equipments had no effect on motorcycle accidents. This shows that the condition of the tires, brakes, and equipments that are used by motorcycle users are still in good condition and function properly.

2) The presence of light from lamps, conspicuity, engine, chassis and mirrors affect the motorcycle accident.

3) From the final modeling results it is obtained that the factors that cause motorcycle accidents are as follows: lamps, engine, chassis, mirrors, and conspicuity.

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PRIMENA MODELA FAKTORSKE ANALIZE U ISPITIVANJU SAOBRAĆAJNIH NEZGODA U GRADSKIM SREDINAMA U KOJIMA SU UČESTVOVALI MOTOCIKLISTI

Aji Suraji, Ngudi Tjahjono

Sažetak: Bezbednosti saobraćaja potrebno je dati najviši prioritet u pogledu smanjenja saobraćajnih nezgoda. Čini se da motocikli doprinose nezgodama više nego druga vozila, naročito u gradskim sredinama. Nezgode se dešavaju zbog lošeg stanja u kome se motocikli nalaze. S toga, važno je poznavati i ovaj aspekt motocikala kao učesnika u saobraćaju, kao osnovu primene akcionog plana za smanjenje rizika od nezgoda. Cilj ovog istraživanja je bio analiza motocikala sa aspekta rizika od nezgode, uključujući pneumatike, kočnice, svetla, motor, brzinu, ogledala, uočljivost na putu i opremu za vožnju. Istraživanje je sprovedeno na osnovu iskustava ljudi koji su doživeli saobraćajnu nezgodu. Upitnik je popunilo 50 ispitanika. Metoda analize korišćena u ovom istraživanju bila je Analiza potvrdnih faktora. Rezultat istraživanja pokazuje da pneumatici, kočnice i oprema za vožnju ne predstavljaju značajne faktore za nastanak nezgode. Međutim, ostale varijable, kao što su svetla, motori, brzina, ogledala i vidljivost su imale bitan uticaj na rizik nastanka nezgode. Konačni rezultati su pokazali da je uzrok saobraćajnih nezgoda u kojima učestvuju motocikli kombinacija varijabli kao što su: svetla, motori, brzina, ogledala i uočljivost motocikala na putu.

Ključne reči: bezbednost saobraćaja, uzrok nezgoda, motocikli, potvrdna faktorska analiza, gradska sredina.