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Strategies for Enhancing Traffic Safety among Adolescent and Adult Motorcycle Riders in Indonesia

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ABSTRACT

This research places emphasis on strategies for enhancing traffic safety among adolescent and adult motorcycle riders. 87.36% of accidents in Indonesia involved motorcycle riders and approximately 25% of these accidents involve underage riders. Therefore, a reasonable solution is needed to reduce the number of accidents in Indonesia. The criteria for respondents in this study were adolescent and adult motorcycle riders. The respondents were interviewed for approximately 10 minutes. The total sample amounted to 530 respondents. The research was conducted in Riau province, Indonesia. The research results indicate that adolescent riders are about 4 times more likely to experience accidents compared to adult riders. Model validation demonstrates an accuracy level of up to 89% for the obtained model. The findings of this research suggest strategies for enhancing the safety of both adolescent and adult motorcycle riders, including advising riders to drive their motorcycles in good stamina and performance, advising riders to rest when fatigued, advising riders not to ride between 12:00 AM and 06:00 AM, enforcing strict measures by law enforcement to apprehend riders without a valid driving license, exercising caution when crossing straight roads and roads with non-variable roadside variability. Another finding from this research is that the model in this research took 3 factor types into consideration that cause accidents including human factors, road and environmental factors and vehicle factor. Then, these factors are modeled simultaneously.

Keywords: Adolescent, Adult, Motorcycle, Riders, Safety, Strategies.

INTRODUCTION

Human factors have the greatest contribution to road accidents, one of which is the factor of driver age (Bucsuházy *et al*., 2020; Chouhan *et al*., 2023). Young riders in Indonesia generally use motorcycles more than other types of vehicles (Lumba *et al*., 2022b). This type of vehicle is less stable compared to others, as motorcycles are supported by only two points. Moreover, the protection for riders is very low, making them vulnerable to severe injuries in case of accidents. Around 87.36% of accidents in Indonesia involved motorcycle riders (Land Transportation Statistics, 2021). Young riders usually have less driving experience compared to adult riders (Kerruish *et al*., 2022), which results in young drivers more often making

mistakes or committing traffic violations while driving (Rahman *et al*., 2021). Young drivers are also frequently distracted while driving (Carter *et al*., 2014). This condition significantly increases the risk of accidents (Moller *et al*., 2021). On the other hand, experienced riders tend to drive more effectively compared to less-experienced riders (Tselentis *et al*., 2020). Several traffic violations commonly committed by young riders include less-frequent use of turn signals (Muley *et al*., 2022), frequent use of mobile phones while driving (Lyon *et al*., 2020; Ali & Haque, 2023; Katrakazas *et al*., 2020), speeding and using illicit substances (Jannusch *et al*., 2021). Research conducted in the Netherlands indicated that 10% of accidents involving riders are caused by mobile-phone usage (Brands *et al*., 2022). Furthermore, young riders not only lack driving experience, but also exhibit less-stable emotional states, which influences their behavior while driving and significantly increases the risk of accidents (Megías-Robles *et al*., 2022; Maghelal *et al*., 2023). Moreover, young riders often use GPS while driving to navigate to their destinations (Lee *et al*., 2014). The use of GPS leads to driver inattentiveness, endangering both their own safety and that of other road users. Additionally, other factors that influence risky driving behavior toward accidents include stress factors (Chen, 2023; Papakostopoulos & Nathanael, 2021), personal factors and attitude factors (Tanglai *et al*., 2021).

The number of accidents involving young people is quite high; however, accident rates go down as they get older. Nevertheless, accident rates go up again for people aged 60-69 years (Zhu *et al*., 2022). Generally, younger riders tend to speed up for a variety of reasons, including road type, visibility conditions, gender considerations (Etika *et al*., 2021) and driving velocity (Babic *et al*., 2022).

Young riders generally have better stamina compared to middle-aged and older riders, allowing them to travel for longer periods to reach their destinations. However, driving for long hours can lead to driver fatigue (Elvik, 2023). Moreover, if the driver hasn't had enough sleep, this can also result in fatigue (Lumba *et al*., 2022b), potentially causing drowsiness while driving and affecting the driver's performance on the road (Wijayanto *et al*., 2021; Takeyama *et al*., 2023), which increases the risk of accidents (Lumba, 2022c). Additionally, this can even worsen the severity of accidents when they happen (Lumba, 2022a). Similarly, driving for extended durations can affect the driver's level of fatigue, leading to an increased risk of accidents (Vipin & Rahul, 2021) and causing more severe accidents (Zhao *et al*., 2023). Feeling tired while driving can reduce the driver's ability to concentrate and can also increase the likelihood of accidents (Lumba, 2022c; Madvari *et al*., 2023), even causing more severe accidents (Davidovic *et al*., 2019). Besides age, another factor that affects the risk of accidents is the gender of the rider. Male riders usually experience more accidents than female riders (Naghawi & Bannoura, 2019), but female riders are more likely to get injured in case of an accident (Cullen *et al*., 2021; Gazder *et al*., 2022).

The number of accident cases in Indonesia reached 100,028 cases in 2020 and then increased to 103,645 cases in 2021 (Land Transportation Statistics, 2021). What's concerning is that 25% of accident victims in Indonesia involve underage drivers. Underage drivers do not have driving licenses, because the age requirement to drive a vehicle in Indonesia is at least 17 years and to possess a driver's license (UU, no. 22, Year 2009). In addition to the above data, accident statistics in Indonesia reveal that one life is lost on the road every 20 minutes. Furthermore, data from the Indonesian Ministry of Transportation (2020) shows that there were 26,906 accident victims aged 10-19 years, 29,281 accident victims aged 20-29 years, 18,553 accident victims aged 30-39 years, 17,980 accident victims aged 40-49 years and 31,740 accident victims aged above 50 years. The data from the Ministry of Transportation shows that the largest number of accident victims is for young riders; then, the accident rate decreases as age increases and then, it increases again among older individuals. The high accident rate among young riders and the decrease in accidents among adult riders become interesting to understand, especially when viewed from three factor types: human factors, road and environmental factors and vehicle factors. The widespread use of motorcycles among teenagers has resulted in a high number of accidents involving teenagers in Indonesia. The total number of motorcycles in Indonesia in 2021 exceeded 100 million motorcycles, specifically 124,042,298 units (Land Transportation Statistics, 2021).

Considering the issues mentioned above, there are a few questions that need to be answered to reduce the number of accident cases and casualties in Indonesia. These questions include: 1) What are the main variables

that contribute to accidents among teenage and adult motorcycle riders? 2) What are the suitable approaches for modeling and implementing traffic-safety strategies for each age group?

METHODS

This research was conducted in Riau province, Indonesia. The number of accident victims in Riau province, Indonesia, in 2022 was 2750, with 651 fatalities, 357 severely-injured victims and 1742 mildly-injured victims. The sample size was determined using the Slovin technique:

$$n = \frac{N}{1 + Ne^2}$$

where (n) represents the sample size, (N) represents the population and (e) represents the margin of error. It is known that the number of accident victims in Riau province (Indonesia) is 2,750 and the value of (e) is 5%. The sample size taken for this research was 530.

$$\frac{2.750}{1 + 2.750 \text{ x } 0{,}05^2} = 349{,}21 \text{ respondents.}$$

Based on the results of calculations using the Solvin technique, the minimum number of respondents was 349.21 respondents, which was rounded up to 350 respondents. The total number of sample members used in this research was 530. Out of this total, 378 were used to analyze the research data and 152 were used to validate the generated model, meaning that for the analysis of the structure of the Bayesian network, a sample of 378 respondents was used, while for model validation, a sample of 152 respondents was used. The sampling method employed was purposive sampling. The criteria of respondents were motorcycle riders who had experienced accidents as riders, not as passengers. Additionally, the respondents consisted of teenage riders aged from 12 to 25 years and adult riders aged from 26 to 45 years. Data was collected by interviewing respondents, which took approximately 10 minutes. Some of the questions asked to the respondents can be seen in the Appendix.

Several variables that influence the model include: behavior while driving, level of fatigue experienced while driving, rider performance while driving, driving time at the time of the accident, duration of riding before the accident, rider's gender, vehicle-engine capacity, possession of a driver's license, feeling of monotony while driving, roadside variability at the accident location and road geometry at the accident location.

The obtained data was analyzed using Bayesian networks utilizing GeNiE 2.0 software (GeNie Software, 2023). Bayesian Networks originate from Bayes theory, an approach to analyze probabilistic data. Thus, it is highly suitable for predicting the severity of accidents, compared to regression analysis (Zong and Zhang, 2013). A Bayesian network illustrates the probability relationship of event A occurring given that event B has occurred. P(A|B) is calculated with the following formula:

$$P(A|B) = \frac{P(B|A)P(A)}{P(B|A)P(A) + P(B|-A)P(-A)}.$$

The calculation of the analysis of the Bayesian network in Figure 1 (with 3 variables) can be performed using the following formula:

P(Y1) = P(Y1|A1, B1) x P(A1) P(B1) +
P(Y1|A1,-B1) x P(A1) P(-B1) +
P(Y1|-A1,B1) x P(-A1) P(B1) +
P(Y1|-A1,-B1) x P(-A1) P(-B1).

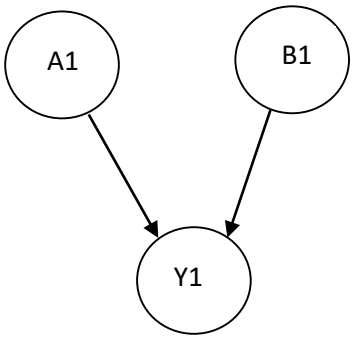

Figure (1): An example of the calculation of the analysis of a Bayesian network with 3 variables

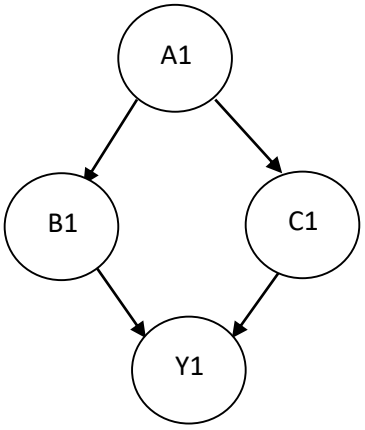

Figure (2): An example of the calculation of the analysis of a Bayesian network with 4 variables

The calculation of the analysis of the Bayesian network in Figure 2 (with 4 variables) can be performed using the following formula:

$$P(Y1) = P(Y1|B1,C1,A1)\ P(B1|A1) \times P(C1|A1) + P(Y1|B1,-C1,A1) \times P(-B1|A1) \times P(-C1|A1) + P(Y1|-B1,-C1,A1) \times P(-B1|A1) \times P(C1|A1) + P(Y1|-B1,-C1,A1) \times P(-B1|A1) \times P(-C1|A1).$$

First, a Bayesian-network structure is created. Nodes represent variables, while arrows signify the relationships between these variables. Next, an analysis is conducted to obtain the Bayesian-network structure model. The obtained model is initially validated to determine its accuracy. Validation is done by calculating the MAD (Mean Absolute Deviation) value using the following formula:

$$\text{MAD} = 1/2 \sum |\text{Actual} - \text{Forecast}|.$$

The actual value represents an event that occurred in the field, as indicated in Table 2, where probability 1 of the accident-probability model is: the rider commits a traffic violation before experiencing an accident (B1) and the rider is also fatigued before the accident occurs (T1) and additionally, the rider has a good performance (F1) before the accident occurs. Based on the data obtained, it is shown that the percentage of riders in such conditions (actual) was 80%, while the percentage of the model calculation (forecast) in such conditions is 75%. Therefore, the absolute-difference value between the field results (actual) and the model-calculation results (forecast) is 5%, as shown in Table 2. If the model results are not significantly different from the field results, various scenarios can be explored to understand the strategic step for improving traffic safety for motorcycle riders.

RESULTS AND DISCUSSION

Table 1 shows the variables and accident statistics at the research location. Among the total respondents, 60% of motorcycle riders involved in accidents were males, while 40% were females. This means that the probability of male riders experiencing accidents is higher than that of female riders. Around 81% of the total respondents who had accidents were teenage drivers and 19% were adult drivers. Furthermore, 80% of the riders involved in accidents did not possess a driver's license (SIM). The high number of riders without a driver's license is likely to contribute to a high level of traffic violations committed by riders, both intentionally and unintentionally. Other data indicates that approximately 23% of riders had poor performance prior to the occurrence of the accident. The cause of poor rider performance while driving is primarily attributed to fatigue experienced by riders during their journeys. Survey results indicate that 28% of riders experienced fatigue before accidents occurred. Additionally, driving duration influences the fatigue levels, particularly during the hours between 12:00 PM and 6:00 PM. Survey data reveals that approximately 48% of accidents occur during the period from 12:00 PM to 6:00 PM. When a rider's driving performance declines, this can negatively impact his/her driving abilities, posing risks to his/her own safety and that of other road users. Additionally, decreased rider performance raises the chances of breaking traffic rules. Statistics reveal that 20% of riders violated traffic regulations before accidents happened. In Jordan, 12.66% of drivers violate red lights (Al-Omari *et al*, 2022). Another significant phenomenon highlights that 68% of accidents took place on journeys lasting less than 30 minutes. This indicates that the duration of the journey is not the primary factor leading to accidents, but rather, other factors, such as driver behavior, driver characteristics, road conditions and vehicles, play significant roles. Regarding road-related factors, 70% of accidents occur on flat and straight roads and 46% of motorcycle riders drive on a road which does not have roadside variability. The conditions of this road can cause drivers to feel monotonous when driving. Survey data indicates that 47% of accidents occur on monotonous roads. Vehicle factors also influence drivers' driving behavior, especially regarding engine capacity (cc). Survey data shows that 26% of the total respondents are motorcycle riders with engine capacities above 125 cc.

The research results indicate that the probability of accidents among young riders aged from 12 to 25 years is 80%, whereas the probability of accidents among adult riders aged from 26 to 45 years is 20%. This means that young riders are four times more likely to experience accidents than adult riders, as shown in Figure 3. Furthermore, despite young riders exhibiting relatively high performance at 77%, their fatigue level while driving is only 28% and the rate of traffic violations among them is 19%. In this scenario, young riders still have 80% likelihood of experiencing

accidents. In addition to the performance of the driver, fatigue while driving and violations of traffic rules, many factors contribute to the high probability of accidents among young drivers, such as less driving experience (Kerruish *et al*., 2022), frequent mistakes while driving and frequent distractions while driving (Carter *et al*., 2014). The higher probability of accidents among teenage riders compared to adult riders is in line with research conducted by (Kerruish *et al*., 2022). Therefore, individuals in such conditions are more likely to commit traffic violations (Rahman *et.al*., 2021), which, of course, poses a risk to rider safety (Moller *et al*., 2021).

Table 1. Variables and statistics

Variable	Evaluation/Record	Percentage (%)
Gender	Male	60
	Female	40
	Adolescent (male)	50
	Adult (male)	10.05
	Adolescent (female)	31.75
	Adult (female)	8.20
Age	Adolescent	81
	Adult	19
Possession of a Driver's License	Yes	20
	No	80
Rider Performance	Good	77
	Not Good	23
Risky Behavior	Violating	20
	Not Violating	80
Fatigue	Yes	28
	No	72
Duration of Driving	≤ 30 Minutes	68
	30 < Duration ≤ 60 Minutes	20
	> 60 Minutes	12
Time Period of the Accident	06.00 AM – 12.00 AM	29
	12.00PM –06.00 PM	48
	06.00 PM – 12.00 PM	21
	12.00 AM – 06.00 AM	2
Road Geometry	Flat and Straight	70
	Curve	30
Roadside Variability	Varied	54
	Not Varied	46
Road Condition	Monotonous	47
	Not Monotonous	53
Engine Capacity	≤ 125 cc	74
	> 125 cc	26

The model equation of accident probability among adolescent and adult motorcycle riders is:

$$P(AC) = P(AC)1 + P(AC)2 + P(AC)3 + P(AC)4 + P(AC)5 + P(AC)6 + P(AC)7 + P(AC)8$$

Example of calculation of accident probability 1 or P (AC)1:

$$P(AC)1 = P(AC|B1, T1, F1, LD, TM, L, M, G, RS, RG, C)\, P(B1|L, G, C)\, P(T1|LD, M, TM)\, P(M|RS, RG)$$

where: P=Probability, B=Risky Behaviour,

B1=Violating, B2=Not Violating, T=Fatigue, T1=Yes, T2=No, F=Rider Performance, F1=Good. F2=Not Good, AC=Accident, LD=Long Duration of Driving, TM=Time of the Accident Occurrence, L=Possession of a Driver's License, M=Road Condition, G=Gender, RS=Roadside Variability, RG=Road Geometry, C=Engine Capacity.

Subsequently, the obtained model is validated to proceed to the next stage. The validation results indicate a difference between the model's results and the actual results (MAD) of 11%, as shown in Table 2. This indicates that the model's accuracy rate is 89%. Furthermore, to develop strategic interventions for enhancing the safety of young and adult motorcycle riders, several scenarios are explored.

Table 2. Calculation of MAD

Driving Behaviour	Fatigue	Performance	Probability of Teenage Accident		Difference (%)
			Actual (%)	Model (%)	
B1	T1	F1	80.00	75	5.00
B1	T1	F2	100.00	75	25.00
B1	T2	F1	70.00	89	19.00
B1	T2	F2	100.00	89	11.00
B2	T1	F1	57.14	68	10.86
B2	T1	F2	100.00	98	2.00
B2	T2	F1	64.37	79	14.63
B2	T2	F2	87.50	87	0.50
					11.00

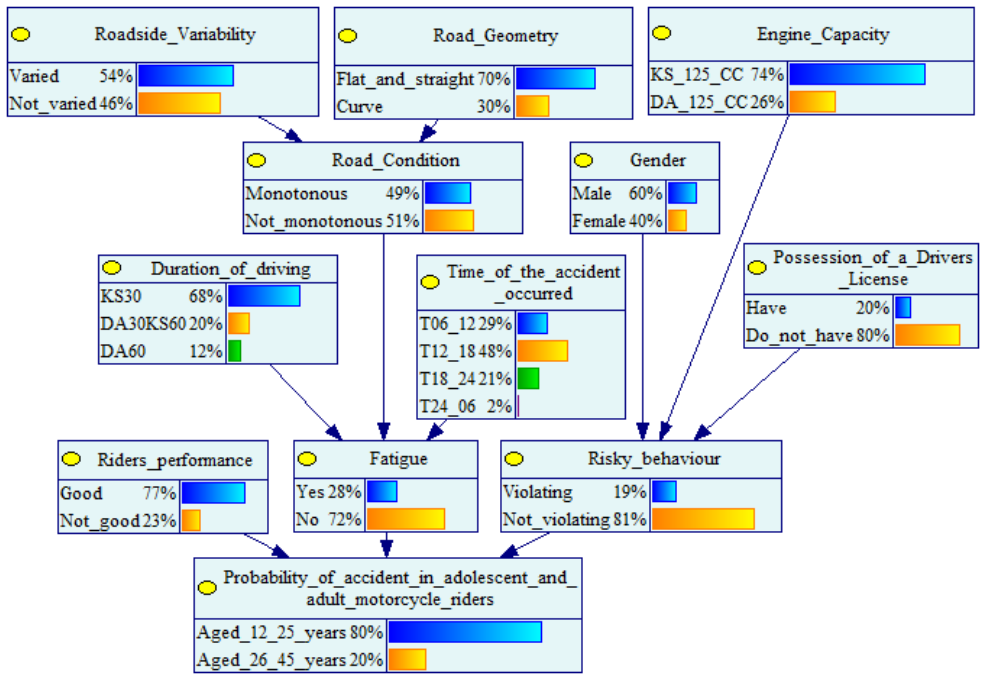

Figure (3): Bayesian-network structure model of accident probability for young and adult riders

In scenario 1, when the rider performance is not good, the probability of teenagers experiencing an accident is 89%, while the probability of adults experiencing an accident is 11%. This means that when the driver's performance is not good, teenagers are potentially 8.09 times more likely to have an accident

compared to adults, as shown in Figure 4. This is in line with previous studies conducted by (Wijayanto *et al*., 2021; Takeyama *et al*., 2023). Based on the survey data, among drivers exhibiting poor performance, approximately 55.68% were driving while fatigued, 57.95% had slept for 6 hours or less at the night before the accident and 44.32% experienced accidents between 12:00 and 18:00. Furthermore, in scenario 2, when riders are fatigued, the probability of teenagers experiencing an accident is 75%, while the probability of adults experiencing an accident is 25%. This means that when teenage riders are tired, they are three times more likely to have an accident compared to adult riders, as illustrated in Figure 5. This is consistent with previous studies conducted by (Lumba *et al*., 2022b; Lumba, 2022c; Madvari *et al*., 2023; Davidovic *et al*., 2020). Based on the data obtained during the survey, it is shown that among the total number of drivers who experienced fatigue while driving, 59.05% slept for 6 hours or less at the night before the accident and 48.57% had an accident between 12:00 AM and 06:00 AM.

In scenario 3, if a driver violates traffic rules, the probability of a teenage driver having an accident is 85%, while for an adult driver being 15%. This means that when a teenage driver violates traffic rules, he/she is 5.7 times more likely to experience an accident compared to an adult driver, as shown in Figure 6. This aligns with studies conducted by (Muley *et al*., 2022; Lyon et al., 2020; Ali & Haque, 2023; Katrakazas *et al*., 2020; Jannusch *et al*., 2021; Brands *et al*., 2022). Based on survey results, among the total number of motorcyclists who violated traffic rules, 50.67% slept for 6 hours or less at the night before the accident, 22.67% were in poor-performance condition and 26.67% drove motorcycles with engine capacities above 125 cc.

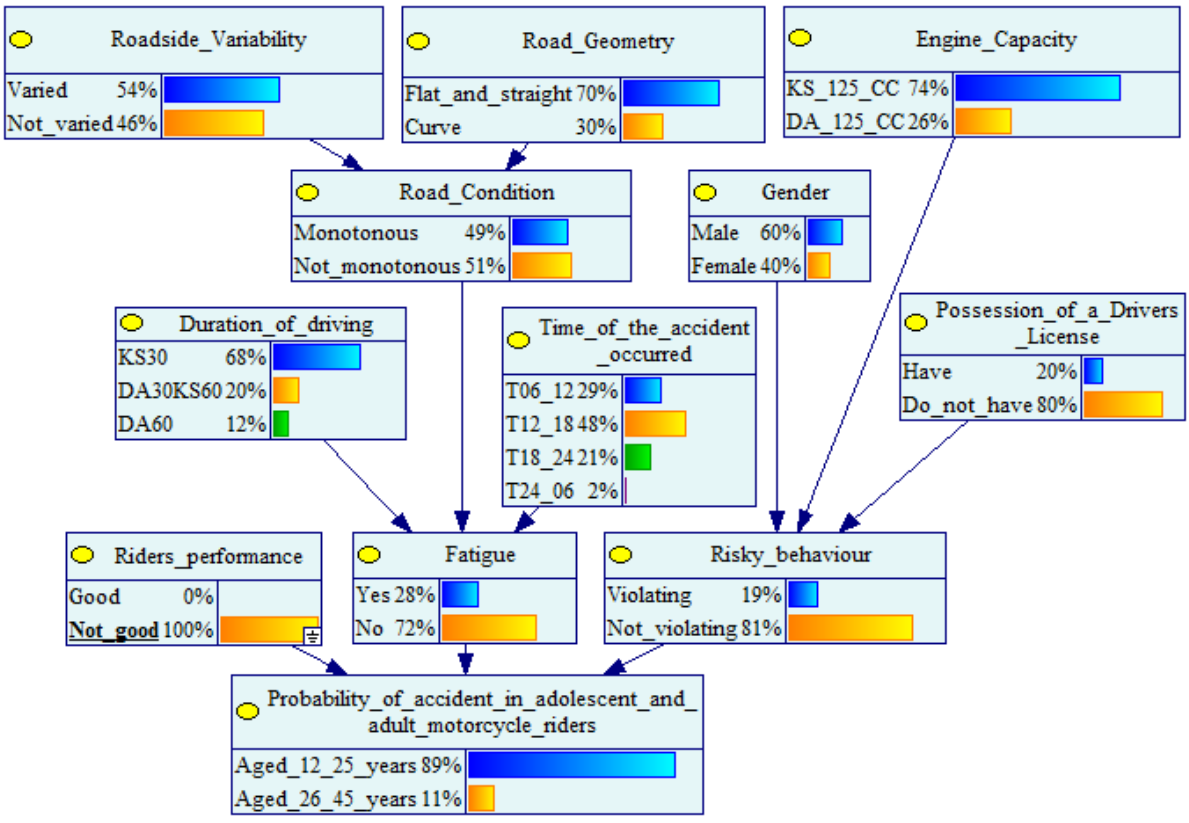

Figure (4): Scenario 1: driver performance while driving

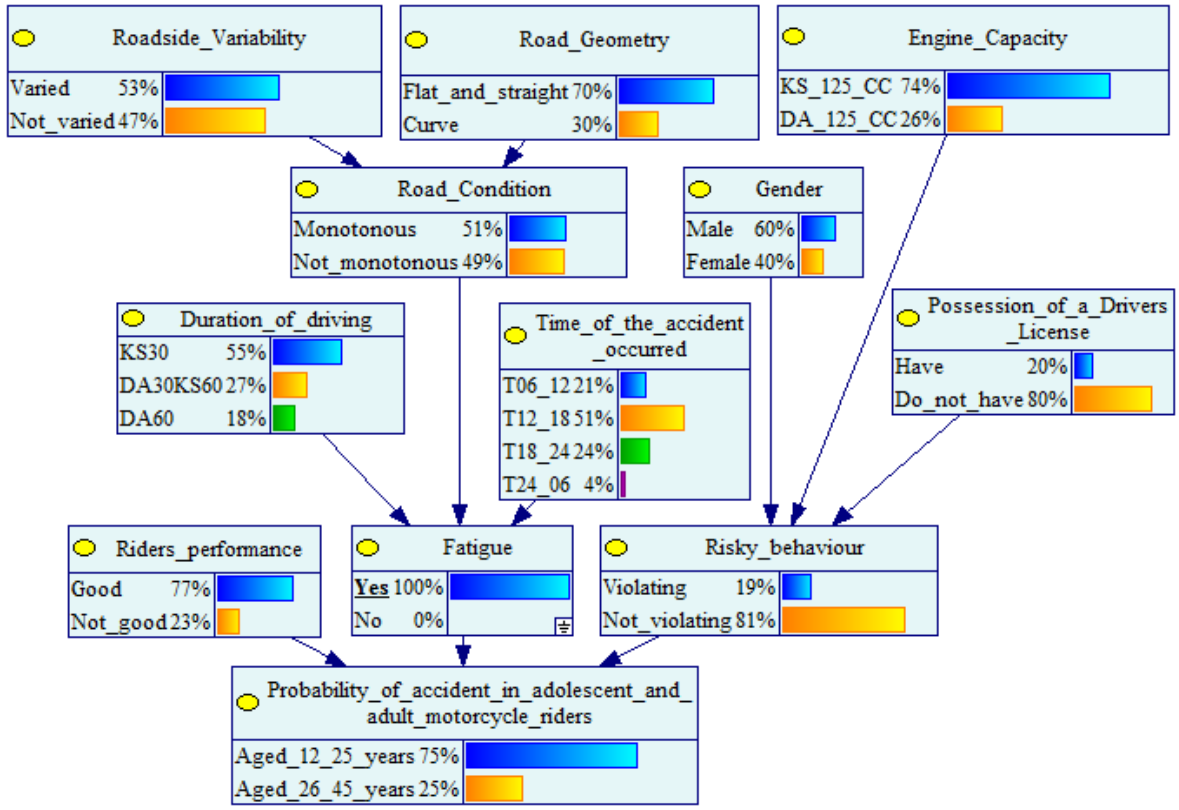

Figure (5): Scenario 2: fatigue experienced by riders while driving

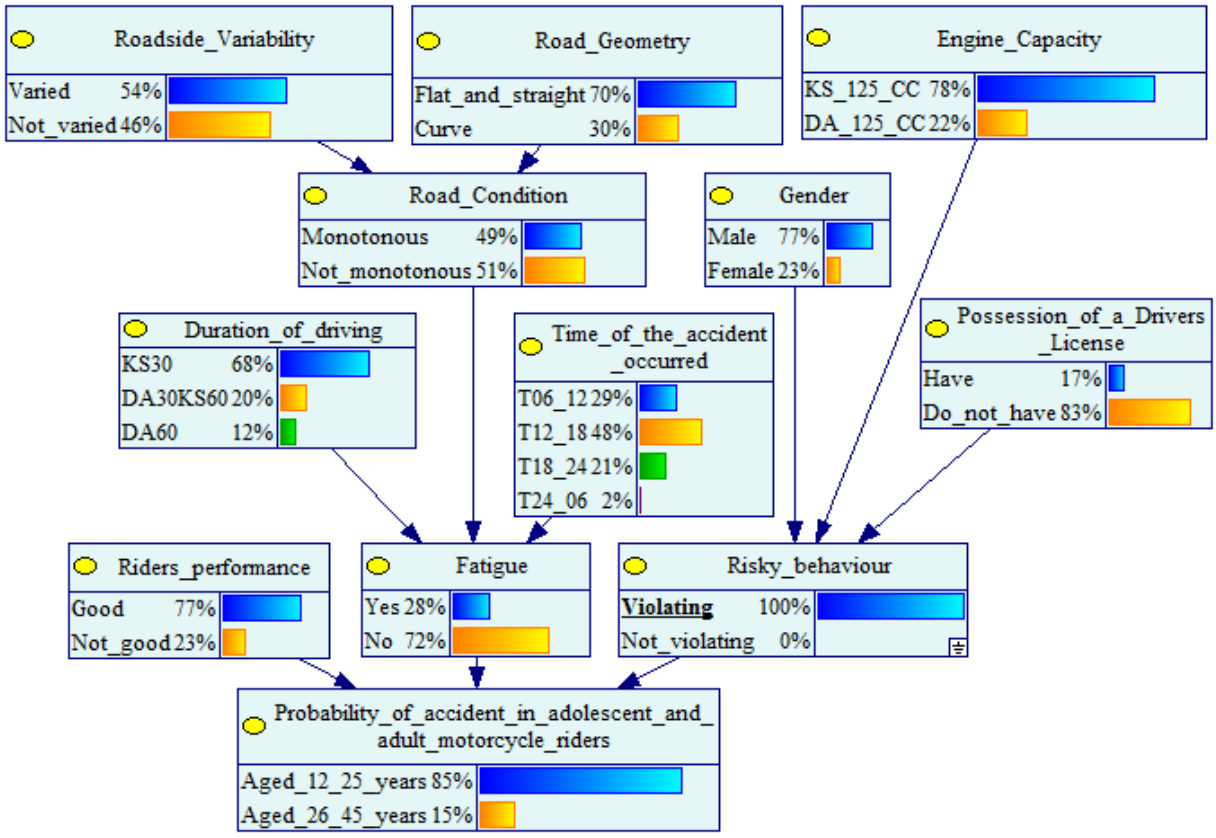

Figure (6): Scenario 3: traffic violations committed prior to driving

Table 3. Scenario 4: correlation between long duration of driving and probability of fatigue

Duration of driving	Probability of fatigue (%)
≤ 30 Minutes	22
30 <to ≤ 60 Minutes	37
> 60 Minutes	42

Scenario 4 indicates that as riders spend more time on the road, the level of driver fatigue increases, as shown in Table 3. This is in line with a study conducted by (Elvik, 2023). Riders who drive for 30 minutes or less have a probability of fatigue of 22%. For trips lasting from 30 to 60 minutes, the probability of the driver experiencing fatigue is 37% and for trips lasting 60 minutes or more, the probability of the driver experiencing fatigue is 42%. Driving time also influences the level of driver fatigue and driver fatigue tends to rise from the morning until midnight. Based on survey data, of the total number of drivers who traveled for a period from 30 minutes to 60 minutes, it was shown that around 28% of drivers experienced fatigue before an accident occurred. Meanwhile, of the total number of drivers who traveled for more than 1 hour, it was shown that around 26.67% of drivers experienced fatigue before an accident occurred.

Scenarios 5a and 5b show that male riders are likely to commit traffic violations at a rate of 24%, while female riders are likely to commit traffic violations at a rate of 11%. This means that male riders are 2.2 times more likely to commit traffic violations than female riders, as indicated in Figure 7 and Figure 8.

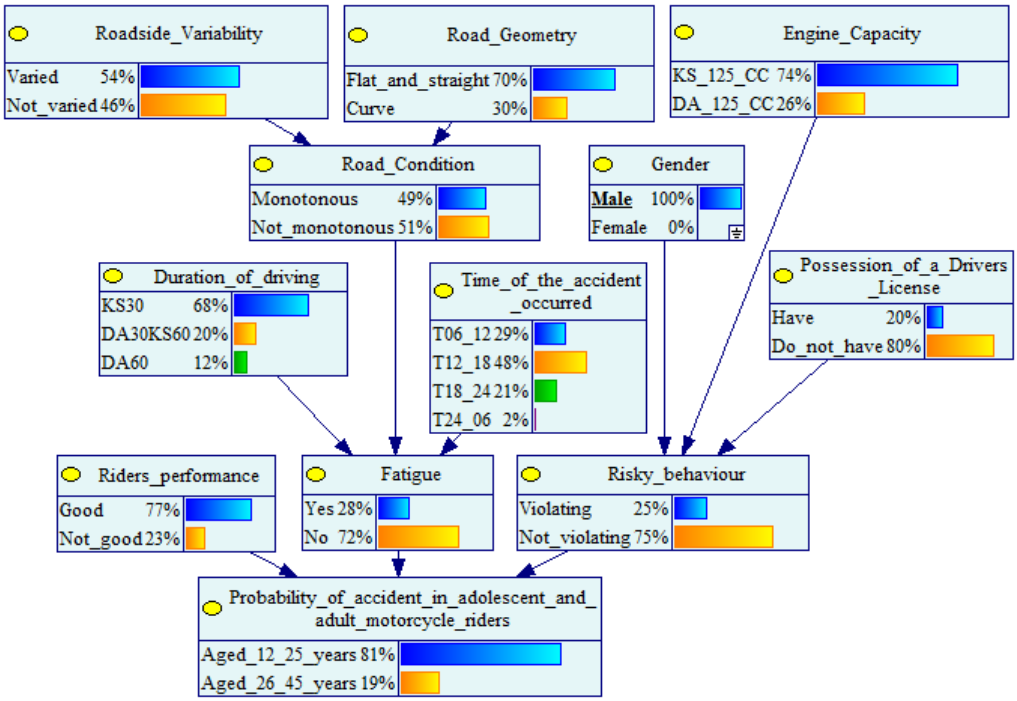

Figure (7): Scenario 5a: probability of accidents in male riders

Meanwhile, in scenario 6, it is shown that riders with a valid driver license (SIM) have a probability of violating traffic rules at 16%, as shown in Figure 9, while in scenario 7, riders without a valid driver license are more likely to violate traffic rules at 20%, as shown in Figure 10. However, besides driver-license ownership, there are other factors influencing drivers to commit traffic violations, such as driver behavior, driver characteristics like age and gender and vehicle-engine capacity (cc). The higher the vehicle-engine capacity (cc), the greater the tendency for drivers to accelerate their vehicles more than usual. To maintain order in traffic, it is necessary to enforce laws for motorcyclists, so that the level of violations of traffic regulations can be reduced. Additionally, it is necessary to provide education in formal schools by including subjects on traffic order in the school curriculum.

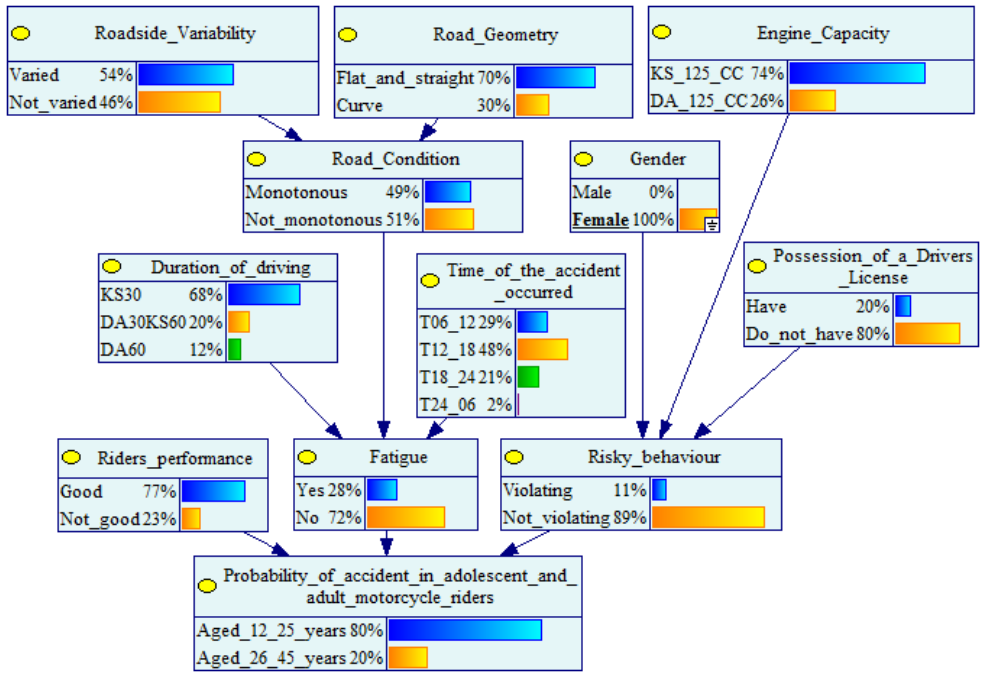

Figure (8): Scenario 5b: probability of accidents in female riders

Several strategies to improve the safety of motorcycle riders include:

1. Riders are advised to ride with good stamina and performance, as the model's results indicate that the probability of accidents decreases by 2% when the rider is in good condition. This means that drivers who have poor stamina, such as lack of sleep, rest or being sick, are expected not to ride. This condition will certainly reduce the driver's performance when driving, thereby reducing the driver's ability to drive safely. The probability of an accident decreases by 2% when the driver is driving with good stamina and performance, which is very meaningful, as the impact of an accident includes death, serious injury, minor injury and loss of property. Riders are advised to take breaks when experiencing fatigue, especially during journeys lasting 1 hour or longer, as the model's results show that the probability of rider fatigue reaches 42% during 1-hour trips. This means that driving for a long duration, specifically one hour or more, can lead motorcyclists to experience fatigue. This is often caused by weather conditions, where riders are not adequately protected from heat, resulting in a quicker onset of fatigue.
2. Riders are advised not to ride between 12:00 AM and 06:00 AM, as the probability of rider fatigue during these hours is 52%. This means that driving between 12:00 AM and 6:00 AM is very risky. Drivers are more likely to experience fatigue and even drowsiness while driving during these hours, making accidents more likely.
3. There is a need for strong law-enforcement actions to apprehend riders without a driver license, as there is a 20% probability of violating traffic rules. This means that efforts are needed from all institutions related to this problem to provide education regarding traffic rules to society. For example, traffic-rule courses should be included in the curriculum from elementary schools to universities.
4. It is advised to be cautious when riding on straight roads or roads with consistent roadside features, as this can increase rider monotony by 17%. Drivers often experience more accidents on straight roads than on curves and intersections. This is due to the increasing sense of monotony for drivers when traveling on a straight road, making it easier for them to experience drowsiness. Similarly, driving on a road with a monotonous view can contribute to this phenomenon.

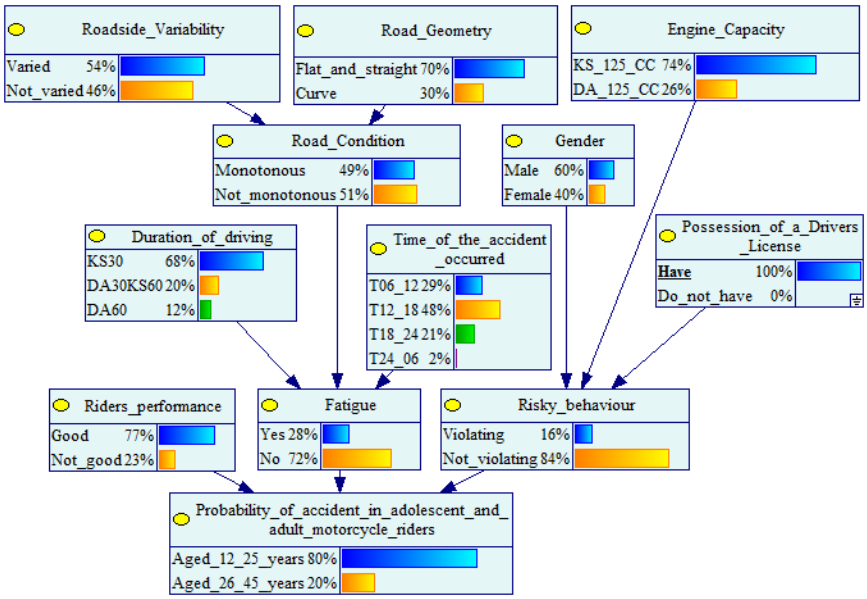

Figure (9): Scenario 6: probability of traffic-rule violations in licensed riders

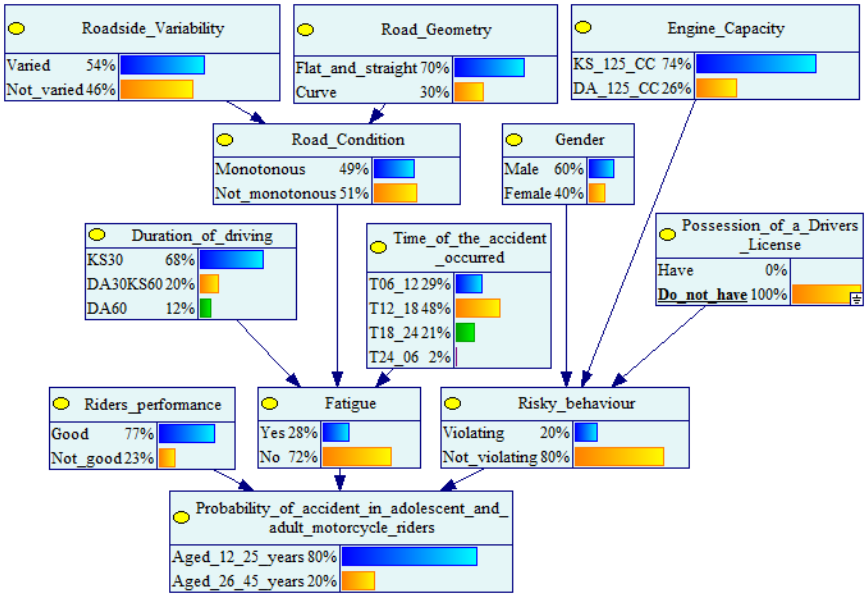

Figure (10): Scenario 7: probability of traffic-rule violations in unlicensed riders

CONCLUSIONS

This research was conducted in Riau province, Indonesia and utilized a sample of 530 respondents, with 378 respondents for data analysis and 152 respondents for model validation. The findings suggest that teenage riders are four times more likely to experience accidents compared to adults. Scenario 1 shows that teenage riders are approximately 8.09 times more likely to experience accidents than adult riders when their driving performance is poor. Scenario 2 indicates that teenage riders are three times more likely to have an accident than adult riders when driving while fatigued. Scenario 3 shows that when teenage riders violate traffic rules, their probability of having an accident is 5.7 times higher than that of adult riders. Scenario 4 suggests that the longer a driver is on the road, the higher his/her fatigue level becomes. Driving time also affects the driver's fatigue level. Driver-fatigue levels tend to increase from the morning until midnight. Scenario 5 indicates that male riders are 2.2 times more likely to commit traffic violations than female riders. Meanwhile, in scenario 6, riders with a valid driver license are less likely to violate traffic rules compared to riders without

a driver license. Strategies to enhance the safety of motorcycle riders include: advising riders to drive their motorcycles in good stamina and performance, encouraging rest breaks when experiencing fatigue, recommending against riding between 12:00 AM and 06:00 AM, implementing strict law enforcement against riders without a license and being cautious when crossing straight roads and roads with varying roadside conditions. However, it is important to understand the study's limitations. Firstly, the sample consists mostly of adolescent riders aged from 12 to 25 years and adult motorcyclists aged from 26 to 45 years who have been involved in accidents, which may limit the findings' generalizability. Second, the analysis was carried out using a Bayesian network, which may have included inherent biases or assumptions. Finally, the estimate of accident likelihood concentrated on human, road and environmental and vehicle components, potentially omitting other essential elements. Despite these limitations, the research results are expected to provide useful information for policymakers, particularly those responsible for creating traffic-safety measures. The study aims to help develop thorough safety programs by tackling various aspects of motorcycle-rider safety, benefiting both young and adult riders in Indonesia. By working with stakeholders like the Ministry of Transportation of the Republic of Indonesia and the Rokan Hulu Regency Transportation Service, the study's findings can guide interventions based on evidence to reduce the dangers of motorcycle riding and enhance the overall road safety.

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APPENDIX

Some of the questions asked to the respondents were:

1. Gender? (Male/Female)
2. Age at the time of the accident?
3. Did you possess a driver's license (SIM) at the time of the accident? (Yes/No)
4. Speed at the time of the accident (km/h)?
5. Were you using any communication device at the time of the accident? (Yes/No)
6. Level of alertness just before the accident occurred?
7. Performance right before the accident?
8. Did you violate traffic regulations before the accident occurred? (Yes/No)
9. Hours of sleep the night before the accident occurred?
10. Did you feel tired before the accident happened? (Yes/No)
11. How long after driving did the accident occur?
12. Time of the accident?
13. How long have you been riding a motorcycle? (Motorcycle driving experience in years)
14. Road geometry just before the accident?
    - Flat and straight
    - Cornering
15. Variation in your view on the left and right sides of the road just moments before the accident occurred?
    - Varied
    - Did not vary
16. Did you feel monotonous during the journey just before the accident?
    - Monotonous
    - Not monotonous
17. Engine capacity of your motorcycle at the time of the accident?
    - ≤ 125 cc
    - > 125 cc

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