# Technical Study of Microsleep Operations as a Follow-up to Drowsiness-Related Accidents on the Terbanggi Besar – Pematang Panggang – Kayuagung Toll Road

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**Abstract**
Microsleep operation on the Terbanggi Besar – Pematang Panggang – Kayuagung Toll Road is a follow-up to the 38.10% of accident caused by drowsiness that occured on this toll road. A technical study of the microsleep operation needs to be conducted based on a self-assesment evaluation of microsleep through visual observation and interview with vehicle drivers. The microsleep self – assesment form includes indicators of drowsiness that have been consulted with Dr. Andreas Prasarja, an expert in polysomnography and sleep medicine. The result of the microsleep evaluation showed that 18% of drivers were in drowsy state. The implementation of the microsleep operation was only effective within a 24-hour time frame. Within two weeks, drowsiness-related accident occured and increased within one month. The 29.41% increase in accident cases proves that the microsleep operation did not have a significant impact in reducing drowsiness-related accident. Therefore, an evaluation of other factor is necessary, including demographic characteristic (gender, age and education) as well as the location of rest area in accordance with regulation from the Ministry of Public Works and Housing. In addition, the driving ability of drivers is also a factor in reducing the risk of drowsiness-related accidents.

**Keywords:** Accident, Drowsiness, Microsleep Operation, Safety, Toll Road

## 1. Introduction

Momentary drowsiness, known as, is an occurrence where alertness and consciousness decrease significantly (Akbar et al., 2024). This brief sleep state lasts for 1 to 15 seconds and is potentially fatal (Skorucak et al., 2020). This phenomenon occurs specifically among drivers of logistics vehicles with heavy loads, which result in slow travel speeds and potential traffic congestion. There are categorized levels of microsleep: warning, slow-onset drowsiness, and falling asleep (Arefnezhad et al., 2020). In the context of highway safety, microsleep can be a primary cause of accidents, particularly for the **Terbanggi Besar – Pematang Panggang – Kayuagung Toll Road**, which covers a considerably long distance. Furthermore, microsleep involves both the physical and psychological conditions of the driver (Afif Mauludi et al., 2021). Other research estimates that 55% of 1,000 drivers showed indications of slow-onset drowsiness while driving, and 23% actually fell asleep behind the wheel (Mccartt et al., 1996). This confirms that drowsiness plays a significant role as a leading cause of accidents compared to other factors

(Connor et al., 2001). Additionally, an accident evaluation conducted by **PT. Hutama Karya (Persero)** on the Terbanggi Besar – Pematang Panggang – Kayuagung Toll Road found that the percentage of accidents caused by drowsiness was 38.10%, surpassing other causes. The difficulty drivers face in individually identifying their own level of drowsiness contributes to the occurrence of accidents (Howard et al., 2004). Therefore, detecting microsleep is a crucial step in preventing traffic accidents (Reynaldi, 2023). Based on survey results and accident reports, it was found that 60% of accidents involving solo drivers occurred between 11:00 PM and 7:00 AM, with 40% occurring on toll roads or highways (Mccartt et al., 1996). These factors are related to demographic characteristics such as age, gender, education, and others (Poudel et al., 2014).
To mitigate accidents caused by drowsiness, the **Toll Road Business Entity (BUJT)** must take follow-up action in the form of **"Microsleep Operations."** This operational scheme involves various parties, including Operations Service (JLO), Highway Patrol (PJR), and the Marines. The implementation method involves diverting vehicles to **Rest and Service Areas (TIP)**. A rapid evaluation is then conducted using a microsleep self-assessment form aimed at identifying whether the driver is in a drowsy state. The indicators used in this evaluation were developed in consultation with **Dr. Andreas Prasadja**, an expert in Polysomnography and Sleep Medicine. If the indicators show the driver is drowsy, they will be directed to rest before continuing their journey. To further increase the effectiveness of these operations, reflective stickers are applied to vehicles found with non-functioning rear lights.

## 2. Objective

The purpose of this study is to determine the effectiveness of microsleep operations in addressing accidents caused by drowsiness. To achieve this, a technical study of the microsleep operations is required with the following limitations:

1. The observed accidents are only those caused by drowsiness, and
2. The observed microsleep operations correspond to the months when drowsiness-related accidents occurred. This research evaluates data from the microsleep forms and its subsequent impact on accident rates after the operations are carried out.

## 3. Review Literature

Based on the **Minister of Public Works and Housing Regulation No. 10/PRT/M/2018** regarding Toll Road Rest and Service Areas, TIP intervals are regulated by type. The Terbanggi Besar – Pematang Panggang – Kayuagung stretch features **Type A TIPs**; according to the regulation, the recommended interval for Type A is every 50 km in each direction (Minister of PUPR, 2018). The presence of fully-equipped Type A TIPs serves to help reduce accidents on the toll road.

## 4. Methodology

The research method used in this study employs both **qualitative and quantitative methods** based on a case study approach, functioning as an explanation of the effects of a specific problem. The workflow of this study is as follows:

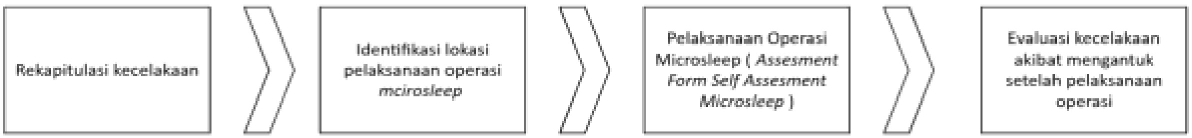


**Figure 1. Microsleep Operation Study Workflow**

The data used consists of both primary and secondary data. The **qualitative method** is conducted by interviewing vehicle drivers based on the indicators found in the microsleep form (Buriro, 2023). The parameters within the microsleep form are as follows:

**a. Driver Information:** (Name, Address, Age, License Plate, Origin Toll Gate).

**b. Visual Assessor Evaluation of the Respondent:**

- Blink frequency.
- Frequent yawning.
- Lack of focus/inability to concentrate.
- Eyes appearing fatigued.
- Over-dimension/Overload (ODOL) vehicles.
- **c. Interview-based Assessor Evaluation:**
  - Caffeine consumption within the last 8 hours.
  - Adequate daily sleep duration (minimum 8 hours for adults).
  - Availability of a relief/backup driver.
  - Length of travel time.

**d. Microsleep Self-Assessment Indicators.**

Subsequently, for the **quantitative method**, accident data is collected and classified according to the following criteria:

a. Weather conditions.
b. Time range of the accident.
c. Cause of the accident.
d. Vehicle class/category.

The scheduling and location of the **microsleep operation** are determined by the dominant accident locations, the time intervals of occurrences, weather conditions during accidents, and vehicle classes. This data is gathered from accident records two weeks prior to the operation. By classifying this data using the specified indicators, dominant accident locations on the Toll Road are identified. The operation is then staged at **Rest and Service Areas (TIP)** located prior to these dominant accident zones.

The study implementation begins with the microsleep operation, which lasts for one hour or until a target of 100 completed microsleep forms is reached. Traffic is diverted into the Rest and Service Area (TIP) with the assistance of the **Highway Patrol (PJR)**, who hold the authority for traffic engineering discretion. Assessors then conduct visual evaluations and interviews regarding the condition of the driver and the vehicle.If the evaluation indicates drowsiness, the driver is recommended to rest before continuing their journey. During the self-assessment process, **Class 1 (passenger cars) and non-Class 1 (heavy vehicles)** are separated into different lanes to prevent traffic congestion. The data obtained is then recapitulated according to its classification as a source of quantitative and qualitative data. Specifically, data for drivers with drowsiness indicators will be correlated with accident data occurring on the **Terbanggi Besar – Pematang Panggang – Kayuagung Toll Road.**

Following the operation, an evaluation is conducted to see if accidents still occur at the dominant locations during the same time frames, measuring the effectiveness of the microsleep operation in reducing accidents. However, accident factors on this long-stretch toll road must also be observed regarding the availability of Rest and Service Areas (TIP).

## 5. Analysis and Discussion

The **Terbanggi Besar – Pematang Panggang – Kayuagung (Terpeka) Toll Road** spans 187 km across the provinces of Lampung and South Sumatra. With a weighted average daily traffic (LHR) reaching 9,000, it is considered quite busy. Accident data samples were taken from June 2024, aligned with the timing of the microsleep operation held between 10:00 PM and 11:00 PM.

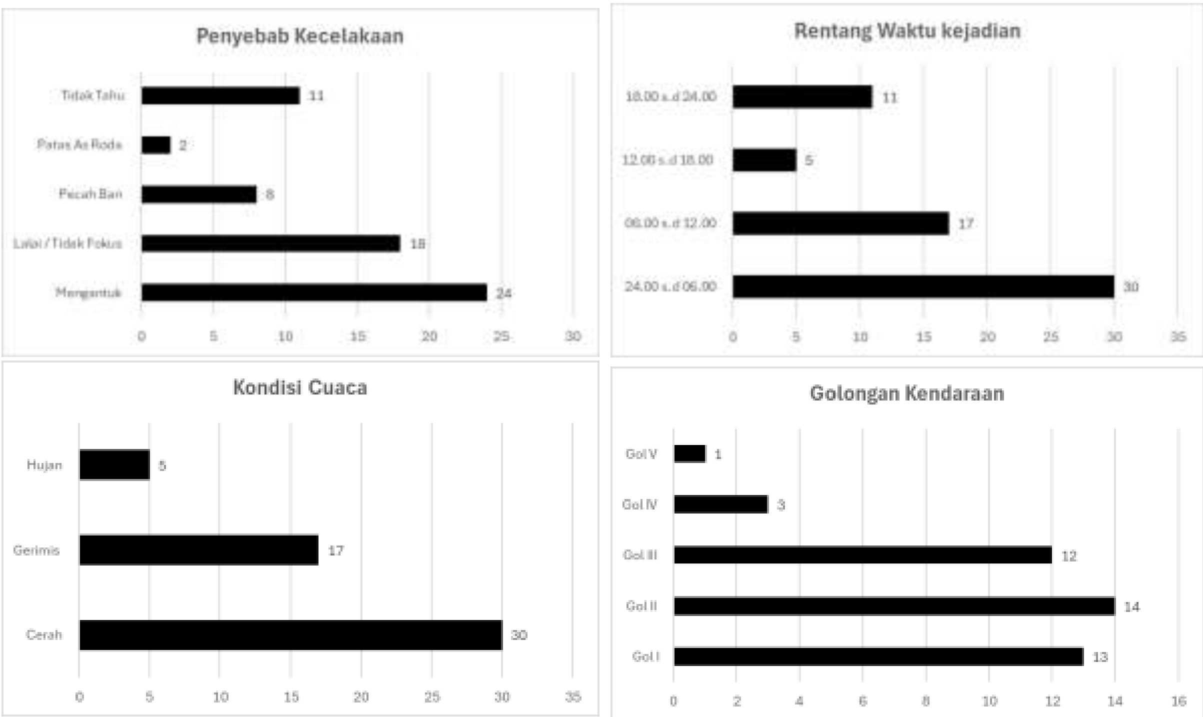


**Figure 2. Accident Data Chart for the Terpeka Toll Road Based on Accident Parameters**

Based on this data, the dominant cause of accidents was drowsiness at **38.10%**. The most frequent time interval for accidents was between **12:00 AM and 06:00 AM**, accounting for 47.62%. Most occurred during clear weather (95.24%), and the dominant vehicle category involved was **Class II (22.22%)**. The decision to conduct the microsleep operation on this route was justified by the prevalence of drowsiness-related accidents and the timing (12:00 AM to 06:00 AM), targeting Class 1 vehicles during clear weather. The microsleep operation took place at two Rest and Service Areas (TIP): **TIP 163 (Lampung toward Kayuagung)** and **TIP 269 (Kayuagung toward Lampung)** on June 26, 2024, from 10:00 PM to 11:00 PM. Since the critical accident window occurs between midnight and 6:00 AM, the operation was held just prior to this window in hopes of preventing subsequent accidents. The results of the self-assessment evaluation are as follows:


**Figure 3. Microsleep Self-Assessment Evaluation Data Chart**

Based on the self-assessment data, the majority of vehicles evaluated at TIP 163 A were non-Class 1(68%), while at TIP 269 B, the majority were Class 1 (51%). Other vehicles did not fall into either category. Regarding the microsleep indicators, 100% of drivers at TIP 163 were found to be alert, whereas at TIP 269 B, 18% of drivers were drowsy. Drowsy drivers were recommended to rest at the TIP before continuing. These drowsy drivers exhibited symptoms such as high blink frequency, fatigued eyes, caffeine consumption more than 8 hours prior, long travel times, operating Overdimension Overload (ODOL) vehicles, and frequent yawning (Makowski et al., 2023). These conditions are linked to demographic characteristics like age, education, and gender (Burdzik et al., 2020). Demographically, the majority of drivers were male, aged between 30 and 40. In terms of education, non-Class 1 drivers were mostly high school (SMA) or vocational school (SMK) graduates.

Following the operation, an evaluation was conducted over 24-hour, 2-week, and 1-month periods to measure effectiveness. The observed periods were June 27, 2024; June 27 – July 11, 2024; and June 27 – July 27, 2024.


**Figure 4. Chart of Drowsiness-Related Accident Data through July 27, 2024**

No drowsiness-related accidents occurred within the 24 hours following the operation. However, after 2 weeks, there were 4 total accidents across both lanes. By the 1-month mark, drowsiness-related accidents surged to 34 cases. Based on this data, the impact of the microsleep operation lasted only 24 hours. The accident rate increased by 30 cases between the second week and the end of the month. The percentage of drowsiness-related accidents in July 2024 showed a 29.41% deviation, being significantly higher than in June 2024. Consequently, the impact of the microsleep operation was not significant in reducing long-term drowsiness-related accidents.

Regarding infrastructure, the Terpeka Toll Road provides Type A Rest and Service Areas (TIP) with complete facilities, including clinics and workshops. While the 40-50 km intervals of these TIPs comply with the Ministry of PUPR regulations, further action is needed in the form of socialization and reminders for road users to rest when tired. Education on self-identifying microsleep indicators is vital for long-distance routes. Furthermore, since accidents are dominant at night (12:00 AM – 06:00 AM), issues like non-functioning rear lights must be addressed. Low-concentration drivers are at high risk for rear-end collisions; thus, applying reflective stickers to vehicles with broken tail lights can help mitigate this risk.

## 6. Conclusion

The microsleep self-assessment results at TIP 163 and TIP 269 showed that only 18% of evaluated drivers were in a drowsy state. Drowsiness indicators included rapid blinking, caffeine intake over 8 hours prior, insufficient sleep windows, and operating ODOL vehicles. The effectiveness of the microsleep operation in suppressing accidents was not significant and only lasted for 24 hours post-implementation. The deviation in drowsiness-related accidents between June and July 2024 was 29.41% (increasing in July). Future studies should delve deeper into demographic characteristics such as age, education, and gender, as these factors significantly influence the occurrence of drowsiness-related accidents.

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