Implementation of A Light Reflector Detector (APC) to Analyze the Percentage of Counterfeit APC in Bali Province

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ABSTRACT

The study aims to examine the proportion of counterfeit APC circulating in Bali. The research is motivated by the safety risks posed by the widespread distribution of counterfeit APC that fail to meet the reflectivity standards of SNI 1907:2015, particularly within Bali's dense traffic conditions and winding road characteristics. Previous studies indicate that 45% of APC used in Bali's traditional markets are non-standard, potentially reducing drivers' visibility distance by up to 30%. To comprehensively assess the distribution of counterfeit APC across the nine regencies of Bali, this study implements a low-cost APC detector developed by the Bali Land Transport Polytechnic, which demonstrates high accuracy. The method used is descriptive statistics, with vehicle sample testing conducted at the Motor Vehicle Testing Units, based on minimum reflectivity thresholds of 120 Lux for red APC and 300 Lux for yellow APC. The results indicate that the overall percentage of counterfeit (non-compliant) APCs in Bali Province reaches 60.7%. The highest failure rate is found in Tabanan Regency (approximately 70%), while the lowest rates are observed in Gianyar and Bangli (both around 52%). Additionally, non-compliant samples are predominantly found in the yellow APC category.

Keywords: equipment procurement efficiency; maintenance efficiency; transportation

INTRODUCTION

Bali Province consists of nine regencies, each with distinct geographical characteristics and increasing levels of traffic density. For example, Badung Regency and Denpasar City have the highest vehicle volumes, while areas such as Buleleng and Karangasem are dominated by winding roads with limited lighting. Gianyar Regency serves as a logistic hub for vegetables and fruits, whereas Tabanan and Jembrana function as major traffic corridors connecting Gilimanuk and Denpasar. These high levels of vehicle density result from tourism and logistics activities, making road safety issues increasingly critical and vulnerable (Firmansyah & Putri, 2019) also on National Highway Traffic Safety Administration (NHTSA) (2021). One such safety concern for trucks and buses is the widespread use of counterfeit additional Light Reflectors (APC).

According to the Regulation of the Director General of Land Transportation No. SK. 5311/AJ.410/DRJD/2018 concerning the technical guidelines for additional APC on motor vehicles, trailers, and semi-trailers, all trucks are required to install additional APC, also regulations regarding the installation of additional APCs are outlined in several national and international standards, including UNECE R104 (2007). APC play an essential role in enhancing vehicle visibility, particularly on dark roads or during adverse weather conditions. However, the increasing use of counterfeit APC that do not comply with the Indonesian National Standard (SNI) poses a serious threat to road user safety (Ministry of Transportation, 2021). Genuine APC products generally have specific reflectance levels that can be quantitatively measured using instruments such as a retroreflectometer, an optical device capable of measuring the intensity of light reflected back from a reflective surface (Sudarman & Taufik, 2020) (Yulianto & Surya, 2020).

Counterfeit APC are generally manufactured using low-quality materials, resulting in reflectivity levels that fail to meet SNI 1907:2015 on motor vehicle reflectors. A study by

Putra and Widyastuti (2020) reported that 45% of APC circulating in Bali's traditional markets do not meet reflectivity standards, potentially reducing a driver's visibility distance by up to 30% at night and thereby increasing the risk of collisions. To date, no comprehensive study has analyzed the percentage of counterfeit APC across all regencies in Bali, particularly using a standardized testing device. In fact, the systematic implementation of APC detection technology could serve as an effective solution to minimize accident risk (Susilo et al., 2019). The effectiveness of APCs is highly influenced by the quality of the reflective materials used, particularly their ability to return light to its source with high intensity (Anderson & Keller, 2018). International guidelines, such as those outlined by the World Road Association (PIARC), emphasize the critical role of vehicle visibility in reducing nighttime traffic accidents (PIARC, 2016).

The quality of APCs available in the Indonesian market varies considerably, with many products fail to meet the specifications required by SNI 1907:2015 (Suryani & Pratama, 2020; BSN, 2015). In Indonesia, the use of APC detectors by relevant institutions remains limited due to their high cost. Previous research shows that the optical performance of vehicle reflectors decreases significantly when the materials used do not comply with standardized reflectance properties (Sharma & Gupta, 2019). Therefore, the Bali Land Transport Polytechnic (Poltrada Bali), as a higher-education institution specializing in motor vehicle testing and safety, has collaborated between lecturers and students to develop a more affordable APC detector. This detector will be used to identify the authenticity of APC installed on trucks throughout Bali Province.

METHOD

Research Approach

This study employs a descriptive statistical method. Through this approach, the data obtained from APC reflectivity measurements are systematically summarized, categorized, and interpreted to identify patterns and levels of non-compliance across the nine regencies in Bali Province. Descriptive statistics allow the researchers to present the distribution of counterfeit APC in a clear and structured manner, providing essential insights into the prevalence of non-standard reflectors and supporting evidence-based recommendations for improving road safety and regulatory enforcement.

Data Collecting

Data collection was conducted at the Motor Vehicle Testing Units in each regency within Bali Province by examining the authenticity of the APC installed on the selected vehicle samples. The total number of samples was determined using the sampling method proposed by Sugiyono (2017), in which samples are allocated proportionally to each regency. Subsequently, the specific number of samples for each area was calculated using Cochran's method (1977) based on the following equation.

$$n_0 = \frac{Z^2.p(1-p)}{e^2}$$

Whereis:

n_0 = Z-score.
Z = Z table based on Confidence Level.
P = Proportion Estimation.
E = Margin of error.

Then after getting the Z-score value, we calculate the number of samples using the following equation.

$$n = \frac{n_0}{1 + \frac{n_0}{N}}$$

Whereis:

n = Number of samples.
N = Number of population.

Data Analysis
From the data processing described above, the distribution and percentage of counterfeit APC users in Bali Province can be identified. The results can then be used as recommendations for relevant agencies to address this issue, ultimately contributing to improved road safety outcomes.

RESULT AND DISCUSSION

Number of Samples

The Z-table value for a 90% Confidence Interval (CI) is 1.645. This confidence level was selected to produce data with high precision while maintaining a manageable sample size. Because the proportion of genuine versus counterfeit APC users is unknown, a proportion of 0.5 was applied. A margin of error of 10% was used, corresponding to the complement of the confidence interval. The result sample size for each region is as Table 1 below.

Table 1. Sample size of each location

No.	Location	Sample Size
1.	Denpasar	44
2.	Tabanan	37
3.	Jembrana	35
4.	Badung	35
5.	Gianyar	21
6.	Klungkung	19
7.	Bangli	19
8.	Buleleng	26
9.	Karangasem	21

The table presents the distribution of sample sizes collected from Motor Vehicle Departments across nine regencies in Bali Province. Denpasar contributes the largest sample size with 44 units, followed by Tabanan with 37 and both Jembrana and Badung with 35 samples each. Moderate sample sizes are observed in Buleleng with 26 samples, while Gianyar and Karangasem each provide 21 samples. The smallest sample size comes from Klungkung and Bangli, with 19 samples each. This distribution reflects proportional sampling based on vehicle inspection activity in each region, ensuring adequate representation for the analysis of APC authenticity.

Results of APC Authenticity Testing

The test results for each sampling location are presented in the chart shown in Figure 1 below.

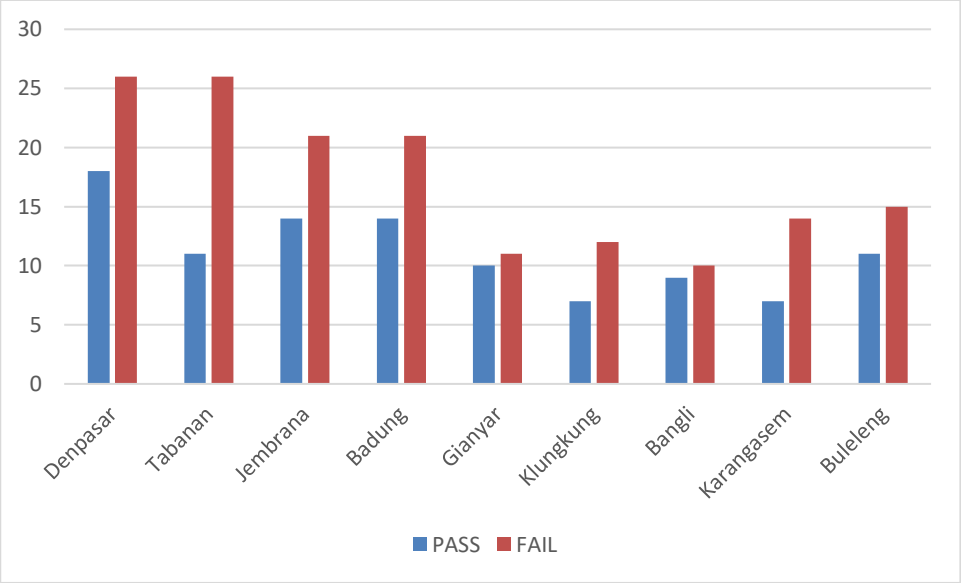


Figure 1. Sample test results per location

The test results reveal a significant overall trend in which the number of non-compliant samples substantially exceeds the number of compliant samples in most locations. Two locations recorded the highest numbers of failed samples Denpasar and Tabanan each with approximately 26 non-compliant units. In Denpasar, the comparison shows 18 compliant samples versus 26 non-compliant ones, while Tabanan presents an even wider gap with only about 11 compliant samples. This high failure trend continues in Jembrana and Badung, both of which recorded around 21 non-compliant samples compared to approximately 14 compliant samples at each location.

Nevertheless, variation exists in the pass-fail ratios across locations. The areas with the smallest total sample sizes and the narrowest differences between compliant and non-compliant samples are Bangli and Gianyar. In Bangli, the difference is minimal, with around 9 compliant samples and 10 non-compliant samples. Gianyar shows a similar pattern, recording around 10 compliant and 11 non-compliant samples. Meanwhile, Klungkung and Karangasem reported the lowest numbers of compliant samples, with only about 7 samples at each location. Although both record low compliance, Karangasem has a higher number of non-compliant samples (14) compared to Klungkung (12).

In summary, the data analysis indicates that geographically, the highest concentration of failed samples occurs in Denpasar and Tabanan. Although some regions, such as Bangli and Gianyar, exhibit a more balanced ratio between compliant and non-compliant samples, the overall pattern across all nine locations shows that non-compliant results dominate the testing outcomes. Buleleng also contributes a notable number of non-compliant samples, with around 15 compared to 11 compliant samples. These findings highlight the need for further investigation into the factors contributing to the high failure rates, particularly in population centers such as Denpasar and Badung. The high proportion of non-compliant APC identified in this study aligns with earlier findings reporting widespread use of low-reflectance APC in heavy vehicles (Hendrawan & Setiawan, 2021).

Meanwhile, the test results for the number of non-compliant samples based on APC color are presented in Figure 2 below.

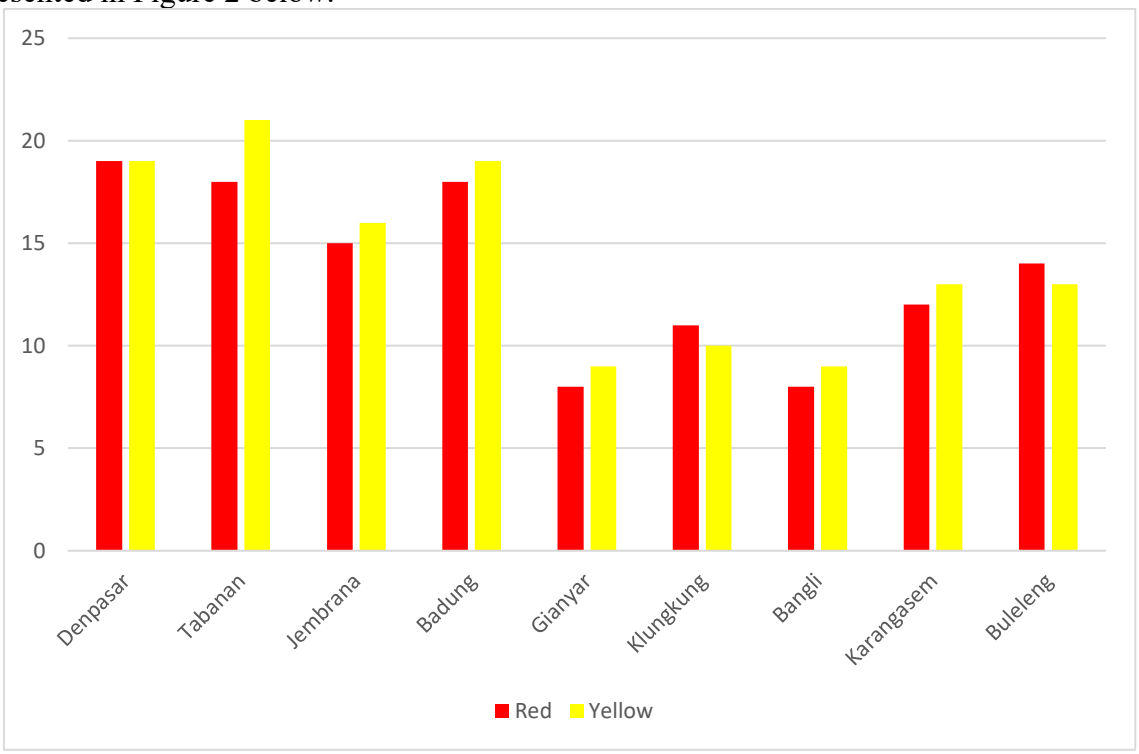
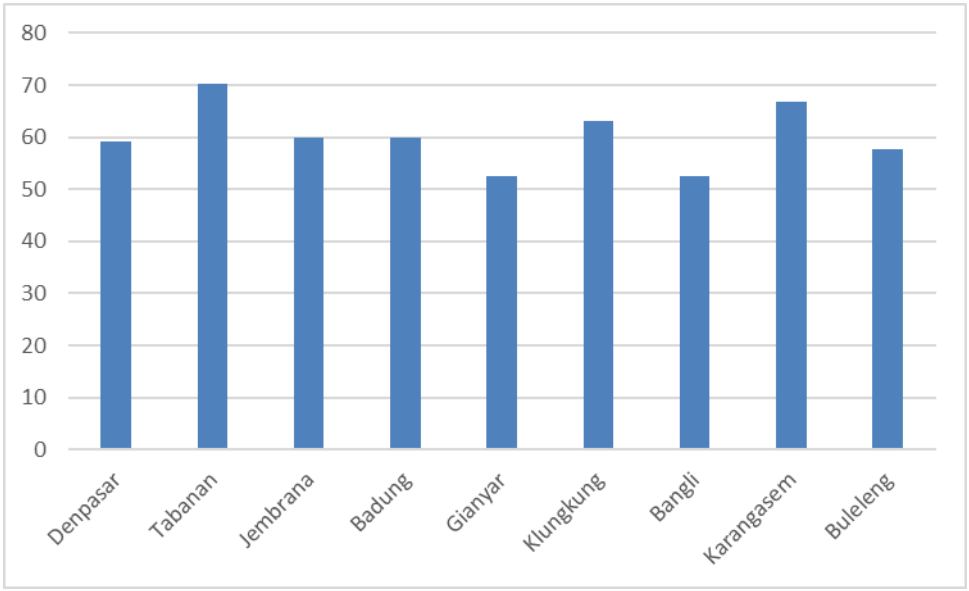


Figure 2. Test Results of Non-Compliant Sample Counts Based on APC Color

The test results indicate that Tabanan recorded the highest number of non-compliant samples, with a clear dominance of yellow APC about 21 samples compared to red ones 18 samples. A similar pattern appears in several other locations, where yellow samples slightly outnumber red samples, including Jembrana, Gianyar, Bangli, and Karangasem. Denpasar shows a nearly equal distribution between the two colors, each with around 19 non-compliant samples, while Badung also reports a slightly higher number of yellow failures. Exceptions occur in Klungkung and Buleleng, where red APC show marginally higher failure counts. Overall, the analysis suggests that yellow APC contribute slightly more to non-compliance across the surveyed regions, with the highest concentrations of failures found in densely populated areas such as Tabanan and Denpasar.

For the percentage of non-compliant APC is presented in Figure 3 below.



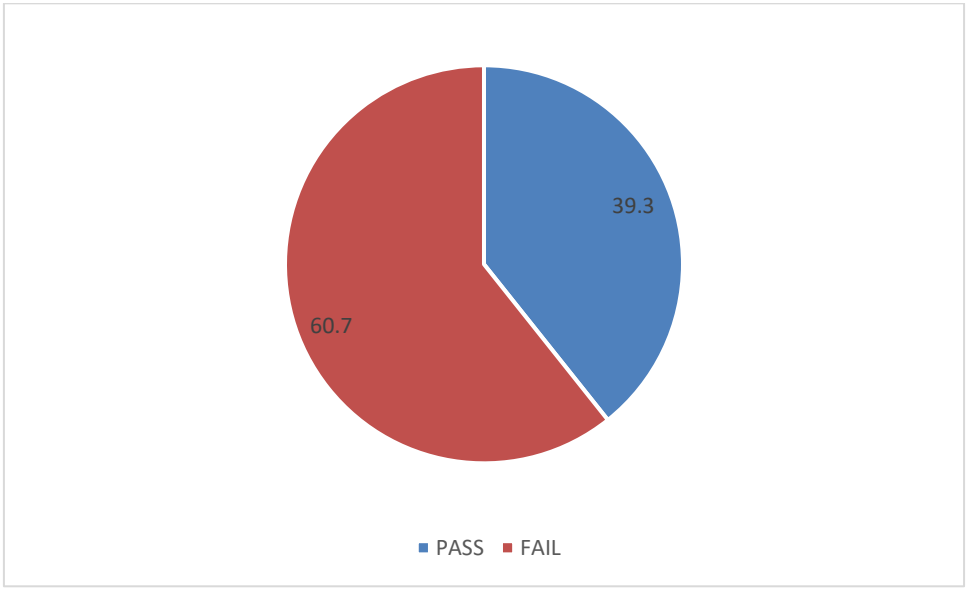


Figure 2. Test Results of Non-Compliant Sample Counts Based on APC Color.

Tabanan recorded the highest non-compliance percentage at approximately 70%, followed by Karangasem at around 67%. Several other regions including Klungkung, Denpasar, Jembrana, and Badung also demonstrated significant failure rates, each nearing or exceeding 60%. In contrast, Gianyar and Bangli showed the lowest non-compliance percentages at roughly 52%, while Buleleng fell in the mid-range at about 58%. Despite this variation, all regions displayed majority failure rates, indicating that more than half of the tested APC samples did not meet the required standards, this is in accordance with the research conducted by Kurniawan & Rahmawati (2021).

At the provincial level, the overall results clearly show that non-compliant APC dominate, with an estimated 60% to 65% of all samples failing the test. Only about 35% to 40% of samples passed. This consistently high level of non-compliance across all nine regions suggests the presence of widespread and systemic issues affecting APC quality, likely related to

environmental factors, handling practices, or production inconsistencies. The dominance of failed samples highlights the urgent need for comprehensive interventions to improve quality control and ensure compliance with testing standards in the future. Similar trends of non-compliance have been documented in other Indonesian cities, where a substantial number of APCs sold do not undergo proper quality testing (Wijaya & Lestari, 2018). These results also parallel the European Commission's observations regarding insufficient quality control of reflective devices on commercial vehicles in developing regions (European Commission, 2020).

CONCLUSION

Based on the survey results, discussion, and analysis presented above, the following conclusions can be drawn:

1. The survey findings indicate that APC that fail the compliance test are classified as counterfeit APCs that do not meet the minimum required standards. Tabanan recorded the highest percentage of goods vehicles using counterfeit APC at 70%, while the lowest percentages were found in Gianyar and Bangli at 52%.

2. The overall percentage of counterfeit APC in Bali Province is 60.7%.

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