# EVALUATING EFFECTIVENESS OF ETLE AND DESIGNING ATCS INTEGRATION FOR TRAFFIC VIOLATION REDUCTION IN MAGELANG REGENCY

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## ABSTRACT
Transportation as a means of public mobility in Indonesia continues to face high traffic accident rates, primarily due to violations such as speeding and red-light running. Electronic Traffic Law Enforcement (ETLE) has emerged as a technology-based law enforcement solution, but its effectiveness remains limited due to the narrow coverage of static systems. This study aims to analyze the effectiveness of ETLE and design its integration with the Area Traffic Control System (ATCS) to enhance traffic violation monitoring in Magelang Regency. The research method is census approach by collecting primary violation data from static and mobile ETLE units during March 2024–2025. Analysis results indicate a decline in violations from 17,495 cases (2020) to 4,739 cases (2023), yet the limited deployment of static ETLE at only one strategic point hinders optimal detection. Integration of ETLE-ATCS across 19 traffic light (APILL) points is proposed to expand coverage through real-time detection, automated verification, and traffic signal adjustments based on real-time data. Simulations of this integrated system demonstrate the potential for more transparent and efficient law enforcement, alongside reduced accident risks. Consequently, the proposed system integration is expected to foster safer, more orderly, and sustainable transportation in Magelang Regency.

Keywords: ATCS; ETLE; ITS; road safety; system integration

## INTRODUCTION
Transportation serves as a means of public mobility and reflects a nation's character and progress. As a reflection of a nation's culture, road safety stands as the fundamental principle in transportation management (Ruci et al., 2024). Accidents have become the primary transportation problem in Indonesia. Traffic accidents have evolved into an increasingly concerning complex issue, as evidenced by the consistent upward trend in annual case numbers (Kandoli et al., 2023; Santalova et al., 2022). The latest data released by the Indonesian National Police Traffic Corps (Korlantas Polri) in 2024 shows a drastic increase, with accident cases rising nearly eightfold compared to the previous year, resulting in 27,000 fatalities (Tempo.co, 2024). Human factors represent one of the primary causes of traffic accidents. The high rate of traffic violations significantly contributes to the increasing number of road accidents (Abdullah & Windiyastuti, 2022).

Human factors contribute significantly to traffic accidents through a combination of drivers' physical condition and driving behavior. A prevalent issue is drivers' habitual violation of traffic regulations (Kandoli et al., 2023). The current prevalence of traffic violations significantly contributes to the rising incidence of road accidents among road users (Amanda A, 2023). The high frequency of traffic violations elevates the risk of road accidents (Wardana, Mahbi, et al., 2024). Traffic violations, particularly red-light running and speeding, are documented as primary causes of road accidents (Abdullah & Windiyastuti, 2022). The Indonesian National Police Traffic Corps (Korlantas Polri) in its 2022 Annual Report stated that 61% of traffic accidents in Indonesia are caused by human factors, with two primary contributors: speeding (28-40% of cases) and traffic sign violations (15-23% of cases), including red-light running, particularly in urban areas (Kemenhub, 2023). Traffic violation statistics from Indonesia's

regional police forces show Metro Jakarta Police Command led with 3.8 million infractions, followed by Central Java (3.1 million), East Java (2.8 million), West Java (2.4 million), and Banten (475,000) (*Regional Police with the Highest Number of Traffic Violations* 2018-2023 (Louis Bisma et al., 2024). This persistent issue significantly elevates accident risks and demands urgent mitigation.

The low public compliance rate with Undang-undang No. 22 of 2009 about Lalu Lintas dan Angkutan Jalan reflects ineffective law enforcement in Indonesia. (Antari et al., 2024). *Electronic Traffic Law Enforcement* (ETLE) has become as an innovative solution for automated traffic law enforcement, this system utilizes camera based technology to detect violations (Aprillia, 2020; Narendroputro & Rusfian, 2023). However, its effectiveness remains limited due to reliance on static camera systems, leaving violations in uncovered areas undetected (Putra et al., 2025). This constraint undermines ETLE's optimal performance in comprehensively reducing violation rates (Alobaidallah et al., 2025). This study examines the integration potential between Electronic Traffic Law Enforcement (ETLE) and Area Traffic Control System (ATCS) to develop a real-time traffic violation response mechanism. By deploying ETLE at all ATCS-integrated intersections, the system's effectiveness is projected to improve through comprehensive violation monitoring, data-driven signal adjustments, and proactive congestion prevention - ultimately achieving safer, more orderly, and efficient transportation systems.

## METHOD

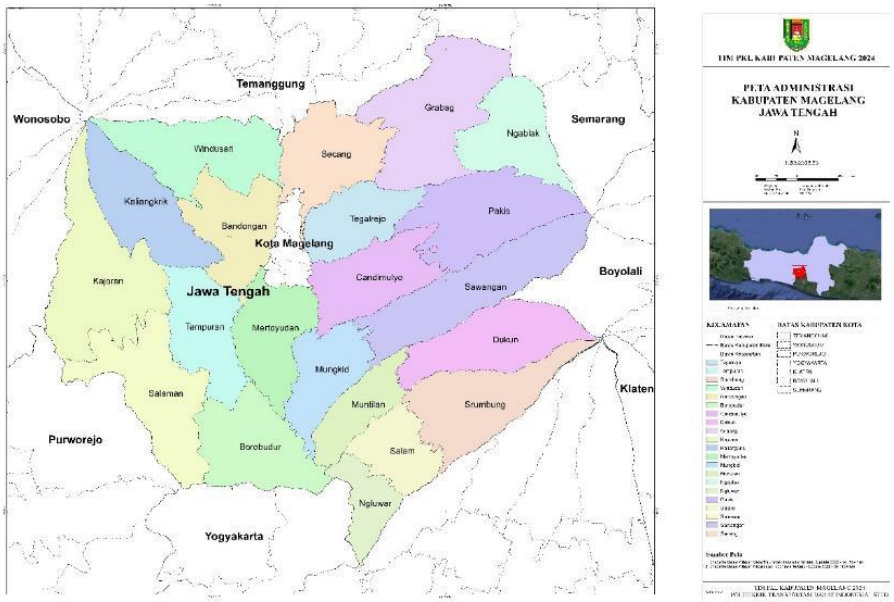


Figure 1 Administrative map of Magelang Regency

Source: Yusuf Dikkidarmawan (2024)

Magelang Regency is one of the regencies located in Central Java Province, Indonesia. The capital of Magelang Regency is Mungkid City. Administratively, Magelang Regency has a unique characteristic compared to other regencies, as Magelang City is situated in its central area. This creates strong connectivity and integration in both transportation and land-use sectors. Geographically, Magelang Regency is positioned between 110°01'51" to 110°26'58" East Longitude and 7°19'13" to 7°42'16" South Latitude. Administratively, the regency is divided into 21 districts (kecamatan) and consists of 372 villages/urban villages (BPS, 2024).

Data collection for this study employed a comprehensive census approach without sampling, encompassing all violation records from both static and mobile Electronic Traffic Law Enforcement (ETLE) systems in Magelang Regency during March 2024 (mobile) and March 2025 (static). Primary data included all violations captured by static ETLE cameras (installed at strategic intersections, school zones, and tourist areas) and mobile ETLE units operating throughout Magelang Regency.

**Static ETLE**

Law enforcement agencies utilize static ETLE systems as traffic violation enforcement tools, deploying them at strategic locations including signalized intersections, road junctions, and high-traffic density areas. These fixed-position devices are limited to capturing violations only when vehicles pass through their field of view. To achieve comprehensive jurisdictional coverage, additional ETLE cameras must be installed at supplementary strategic points to maximize surveillance effectiveness (Putri, 2023).

**Mobile ETLE**

The mobile ETLE system functions as an electronic ticketing solution that captures traffic violation evidence through two distinct device configurations. First, the vehicle mounted mobile ETLE employs portable camera units installed on Traffic Police (Polantas) patrol cars. These automated cameras operate in high risk locations not covered by static ETLE systems, continuously recording traffic violations while the patrol vehicle is in motion. Second, the handheld mobile ETLE utilizes smart devices or smartphones as enforcement tools, enabling officers to directly document violations (Aldizar et al., 2025). This portable configuration offers dynamic deployment capabilities across patrol zones, providing significantly greater operational flexibility compared to fixed ETLE installations. The system's mobility allows for adaptive enforcement strategies that can respond to real-time traffic conditions and violation patterns, particularly in areas where permanent infrastructure would be impractical or cost-prohibitive. (Wardana, et al., 2024).

**ATCS**

The Area Traffic Control System (ATCS) serves as a real-time traffic management solution designed to dynamically and instantaneously respond to changing traffic conditions. Its primary objectives are to optimize seamless vehicle movement and reduce waiting times at intersections. The system adapts signal timing patterns based on actual traffic volume, thereby enhancing the operational efficiency of traffic signals. Traffic lights operate through fixed-time cycles, with each intersection direction following a sequential phase pattern: red (stop), yellow (warning), and green (go). The system's ability to adapt to vehicle flow fluctuations makes ATCS an effective solution for reducing congestion and improving transportation infrastructure responsiveness (Maulidya, 2022).

## RESULT AND DISCUSSION

### Vehicle Ownership Data in Magelang Regency

According to 2024 data from the Magelang Regency Police (Polres Magelang), vehicle numbers in the region showed consistent growth from 2019 to 2021. Motorcycles dominated with significant increases, rising from 437,411 units in 2019 to 454,980 units in 2020, and reaching 472,549 units in 2021. Passenger cars also demonstrated steady growth, climbing from 39,232 units (2019) to 43,327 units (2020), and 47,422 units (2021). Meanwhile, trucks increased from 16,338 units (2019) to 17,643 units (2020), and 18,948 units (2021), while buses recorded the lowest growth from 1,004 units (2019) to 1,010 units (2020), and 1,043 units (2021). This data reveals growth trends across all vehicle categories, with motorcycles

remaining the dominant transportation mode in Magelang Regency. These patterns indicate the persistent predominance of private vehicle usage, which facilitates high mobility but simultaneously elevates traffic accident risks partly attributable to violations and non-compliance among motor vehicle drivers. Number of vehicles recorded in Magelang Regency Police (POLRES Magelang) 2024 data

Table 1.
Vehicle Statistics of Magelang Regency

| Vehicle Clasification | Year | Static |
|---|---|---|
| Motor Cycle | 2019 | 437.411 |
| | 2020 | 454.980 |
| | 2021 | 472.549 |
| Passanger Vehicle | 2019 | 39.232 |
| | 2020 | 43.327 |
| | 2021 | 47.422 |
| Bus | 2019 | 1.004 |
| | 2020 | 1.010 |
| | 2021 | 1.043 |
| Truck | 2019 | 16.338 |
| | 2020 | 17.643 |
| | 2021 | 18.948 |

**Exsisting Condition of ETLE in Magelang Regency**

Table 2.
Traffic Violation in Magelang Regency

| Description | Year | | | |
|---|---|---|---|---|
| | 2020 | 2021 | 2022 | 2023 |
| Traffic Violations | 17.495 | 9.410 | 7.976 | 4.739 |
| Warnings | 9.608 | 4.261 | 4.310 | 4.478 |
| Fines | 1.028.746.000 | 306.309.000 | 486.443.000 | 436.856.000 |

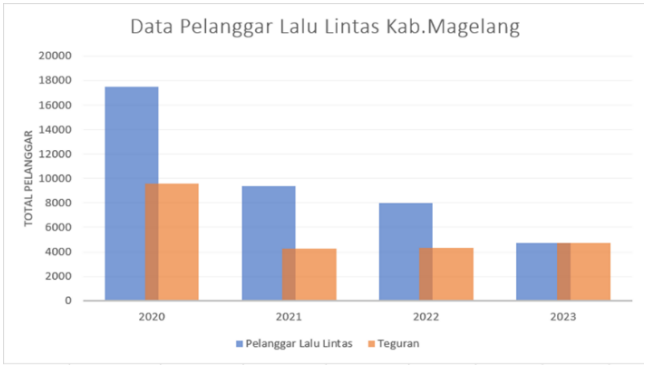


Figure 2 Graph Traffic Violation in Magelang Regency

The graph above illustrates the number of traffic violators recorded by the Magelang Regency Police (Polres Magelang). During the 2020-2023 period, Magelang Regency exhibited a significant downward trend in traffic violations, decreasing from 17,495 cases in 2020 to nearly half that number (9,410) in 2021, then continuing to decline to 7,976 in 2022 and 4,739 in 2023. Similarly, warnings showed a sharp reduction from 9,608 in 2020 to 4,261 in 2021, but subsequently stabilized with slight increases to 4,310 in 2022 and 4,478 in 2023. Fine revenue peaked in 2020 at Rp 1.028 billion, plummeted to Rp 306 million in 2021 following the decrease in violations, then rose to Rp 486 million in 2022 before declining again to Rp 436 million in

2023. This fluctuation reflects both changes in average fines per violator and evolving enforcement policies during and after the pandemic period.


Figure 3. Static ETLE Located in Magelang Regency

The static ETLE in Magelang city is located on Jalan Magelang-Purworejo Glagah, Banjarnegoro, Mertoyudan District, Magelang Regency, Central Java. The ETLE condition remains good as this static ETLE is new, assisting the duties of the mobile ETLE previously used by the Police (POLRES) to enforce ticketing sanctions against road users violating regulations. The process of handling traffic violations through electronic devices is formally regulated in Undang-undang No. 22 Pasal 272 Lalu Lintas dan Anguktan Jalan about the Traffic Law. This article states that electronic devices can be utilized as supporting tools in law enforcement efforts related to traffic and road transportation violations. Furthermore, recordings from these devices hold legal force as valid evidence in court proceedings. In field conditions, the Static ETLE in Magelang Regency has enforced actions against road users. The implementation of ETLE in Magelang Regency has recorded ETLE violators in the system:

Table 3.
Traffic Violations Capturing by Static ETLE

| Year | Month | Violations |
|---|---|---|
| 2024 | Maret | 1853 |
| 2025 | Maret | 1688 |

The data indicates that violators recorded by the ETLE system totaled 1,853 in March 2024 and 1,688 in March 2025, demonstrating that ETLE in Magelang Regency has not yet maximized traffic law enforcement. This limitation occurs because the system is installed at only one road section and cannot accommodate most roads across the regency.


Figure 4. Procedure ETLE Mechanism

The procedure for settling traffic violations recorded via Electronic Traffic Law Enforcement (ETLE) begins with data verification on the Vehicle Registration Certificate (STNK). If the vehicle owner's and violator's data match, the violator can scan the barcode through the

designated website. Subsequently, the violator must fill in identity details according to the driver's National ID Card (KTP). After data confirmation, the violator waits 24 hours to receive an SMS notification containing the form code, BRIVA code (Bank Indonesia Virtual Account), and court hearing schedule. Fine payment can be made online via transfer to BRIVA or offline by visiting designated offices. If the STNK shows no blockage after payment, the case is considered resolved. However, if the violator attends the hearing at the Prosecutor's Office, any unused fine balance (e.g., maximum fine Rp250,000 reduced to Rp100,000 in court) will be refunded. Violators may also retrieve previously confiscated evidence after the hearing proces. These sanctions aim to create a deterrent effect and educational action so violators recognize their mistakes and avoid repeating violations in the future. Through this mechanism, it is expected that public legal awareness will increase and compliance with traffic regulations can be sustainably achieved.

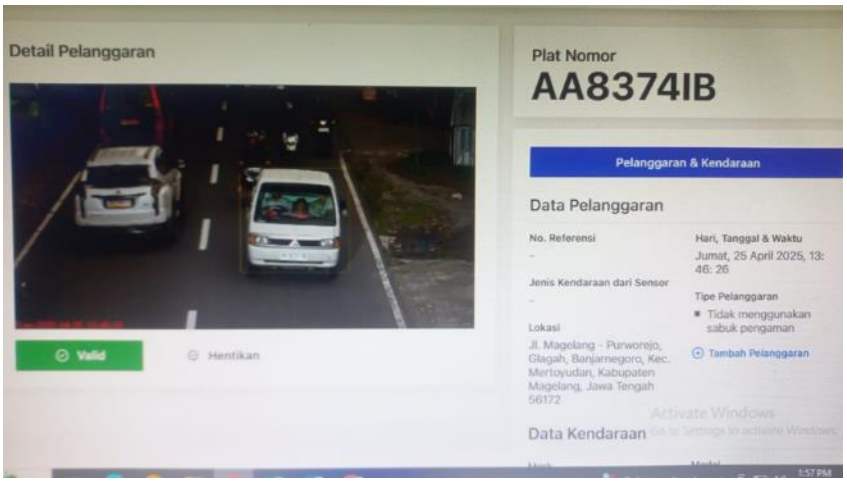

Figure 5 Result of ETLE Captured

The captured results from the Electronic Traffic Law Enforcement (ETLE) system show electronically recorded traffic violations. The data includes:

1. Vehicle Identification (Number plate and vehicle type).
2. Violation detail:
    a. Violation type (ex. Speeding, red light running, not wearing helmet, and others).
    b. Time, date, year, and location coordinat violation.
3. Visual Documentation: Photos or video recordings serving as evidence of violations.

Figure 6. Reporting of ETLE PRESISI App

After the ETLE camera system captures a traffic violation, officers verify the data before uploading it to the database. This is followed by the issuance of a traffic ticket and the corresponding fine. Failure to settle the fine will result in the vehicle's registration number being blocked by the Traffic Police Unit (Satlantas)

The ETLE system significantly assists police in traffic law enforcement. However, its implementation faces challenges: static ETLE units can only monitor roads with installed cameras, covering a small fraction of Magelang Regency's road network. Additionally, road users covering license plates commit illegal acts (Pasal 287 UU LLAJ) that endanger public safety. ETLE exists to regulate traffic, not entrap violators. By obscuring plates, individuals undermine a system designed to protect all road users.

Regarding Road Users Who Forge Others' License Plates: 'Borrowing another person's plate during violations constitutes high-risk identity fraud. If caught, penalties include not only fines but also criminal prosecution under Article 263 of the Criminal Code (KUHP). Beyond harming the legitimate plate owner, this action undermines trust in the legal system. Note: ETLE systems employ advanced technology capable of detecting fraud through vehicle movement patterns and driver facial recognition.

**Integrated ETLE with ATCS**

To maximize traffic law enforcement programs for accident prevention, Magelang Regency requires an integrated system with comprehensive road coverage. While ETLE is crucial, its implementation still faces coverage limitations. With Magelang's expansive terrain where districts and villages interconnect through road networks installing ETLE at every traffic-light intersection integrated with ATCS (Area Traffic Control System) would dramatically expand enforcement reach. This strategic integration is visually demonstrable through Magelang's Traffic Light Map (Peta APILL), which identifies optimal installation points across 21 districts. Magelang Regency has approximately 19 traffic light (APILL) points distributed across its territory. System integration is essential to expand coverage and enhance ETLE effectiveness in supporting safer transportation. The following diagram illustrates the integrated ETLE-ATCS system designed to maximize enforcement efficiency in Magelang Regency.

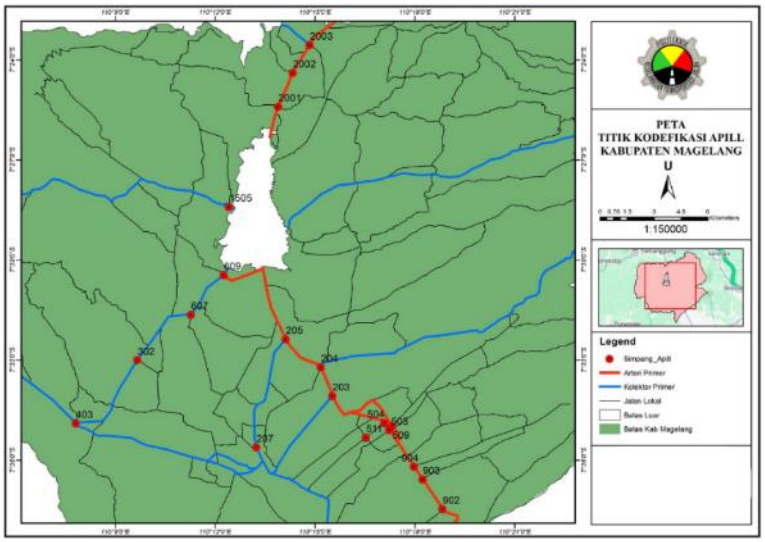


Figure 7 Traffic Light Map Point on Magelang Regency

The diagram details the integrated workflow of ETLE (Electronic Traffic Law Enforcement) and ATCS (Area Traffic Control System) for electronic traffic law enforcement, beginning with violation detection by vehicle detectors and traffic signals synchronized with ATCS & ETLE CCTV systems that record violating vehicles. Following detection, violation data undergoes verification against motor vehicle registry records, and if validated, the system automatically generates a confirmation letter with barcode through https://etle.polri.go.id, which is mailed to the vehicle owner's registered address with a mandatory seven-business-day response window upon receipt. Should violators acknowledge the offense, officers issue a traffic citation and virtual payment account; failure to pay or respond triggers STNK (vehicle registration certificate) blocking, while successful payment resolves the case without further penalties collectively establishing a transparent, efficient, and technology driven enforcement ecosystem.

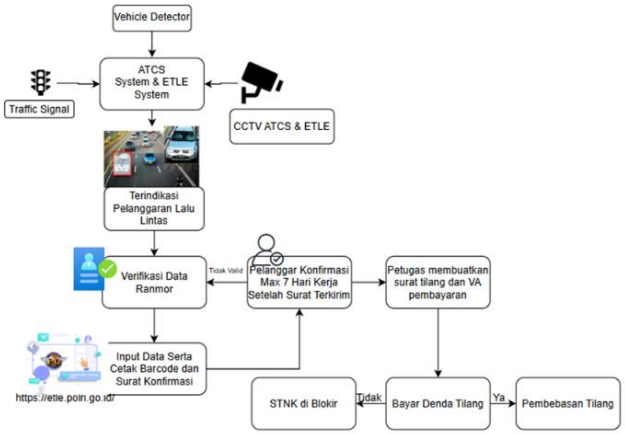


Figure 8 Integrated of ETLE and ATCS System Results

The comprehensive integration of ETLE with ATCS would significantly enhance traffic law enforcement effectiveness and coverage. This synergy enables ETLE deployment beyond isolated road segments, extending to all intersections equipped with CCTV or traffic signals (APILL). Consequently, traffic violations occurring across multiple junctions can be automatically detected and penalized without physical officer presence. This expansion of monitoring scope will substantially improve road regulation compliance while establishing more orderly, efficient, and sustainable traffic systems throughout urban areas.

## CONCLUSION

Based on the analysis of vehicle and traffic violation data in Magelang Regency, there is a trend of increasing private vehicle ownership, particularly motorcycles, rising from 437,411 units in 2019 to 472,549 units in 2021. This reflects high mobility levels and growing potential for traffic accident risks. Meanwhile, traffic violations recorded through the static ETLE system show a decrease in violators from 17,495 cases in 2020 to 4,739 cases in 2023, accompanied by fluctuating fine amounts that reflect adaptive law enforcement policies during the pandemic and post-pandemic period. On the other hand, the coverage limitation of the static ETLE system installed at only one location demonstrates suboptimal violation detection across the vast and evenly distributed road network throughout Magelang Regency.

To address these limitations, innovation is required through system integration between ETLE (both static and mobile) and ATCS (Area Traffic Control System) at all intersections equipped with traffic lights (APILL) and CCTV. With a real-time violation detection mechanism by vehicle detectors and traffic signals directly connected to the ETLE-ATCS system, violation data can be immediately verified, traffic tickets automatically issued, and the law enforcement process conducted more efficiently and transparently. Implementing this integration is expected

not only to expand surveillance coverage and improve road user compliance, but also to support the creation of safer, more orderly, and efficient transportation systems across various urban areas of Magelang Regency.

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