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Research Article

Developing a Smart Transportation Model to Enhance Road Safety in the Eastern Economic Corridor of Thailand

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ABSTRACT

Road accidents remain a critical issue that cause significant losses to live, the economy, and Thai society. Although legal measures, infrastructure development, and public awareness campaigns have been implemented, the level of loss remains high, reflecting the urgent need to develop new, integrated, and sustainable approaches. This study aims to develop a model of intelligent transportation to enhance road safety in the Eastern Economic Corridor (EEC) of Thailand through multidimensional integration. These dimensions include effective law enforcement, safe infrastructure design, vehicle standards and maintenance, modern emergency assistance systems, accident database management, safety awareness campaigns, and the promotion of intelligent transportation and public transit. The findings of this research provide a framework for policy and practical guidelines that can reduce accidents, improve road safety, and support the development of the EEC as a safe and sustainable economic zone in the future. This is achieved through coordinated efforts in law enforcement, infrastructure development, emergency response systems, data collection and monitoring, driver behavior campaigns, and investment in smart transportation systems.

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1. Introduction

Road accidents remain one of Thailands major national challenges, affecting lives, the economy, and overall quality of life. This issue is particularly critical in the Eastern Economic Corridor (EEC), a strategic zone for investment and transportation. Road safety problems in this area have become significant obstacles to economic progress and sustainable development. Although various measures have been implemented–such as law enforcement, infrastructure development, and public awareness campaigns–the number of accidents and associated losses remains high. This reflects that existing measures may be insufficient and lack systematic integration.

Previous studies indicate that reducing road accidents requires a holistic approach, including strict law enforcement [14], safe infrastructure design [4], the development of vehicle safety standards and emergency assistance systems [12, 15] and fostering a safety culture through public education [1]. At the same time, the rise of intelligent transportation systems presents new opportunities to enhance safety through improved traffic management, reduced private vehicle congestion, and the application of technology for accident monitoring and prevention [7]. Therefore, developing a model for intelligent transportation to improve road safety in Thailands EEC is both important and urgent. The goal is to establish an integrated framework that aligns policy, technology, and social dimensions to enhance safety measures, reduce losses, and support the EECs long-term development into a safe and sustainable economic zone.

Furthermore, research on this topic is academically and practically significant, as it fills gaps in knowledge regarding road safety management within special economic zones–areas that differ from general regions in terms of infrastructure characteristics, concentrations of labor populations, and transportation density [13]. This study thus aims not only to develop an intelligent transportation model to improve safety but also to lay the foundation for future public policies that address structural and technological challenges [6]. Additionally, it will strengthen the EECs competitiveness as an economic hub linked to regional and global networks. The results of this research are expected to significantly improve residents quality of life, reduce economic costs caused by accidents, and foster a sustainable road safety culture [2].

Research objectives

1) To examine design approaches for intelligent transportation systems that can effectively support the enhancement of road safety.

2) To develop an appropriate intelligent transportation model for improving road safety in Thailands Eastern Economic Corridor (EEC).

2. Literature review

Development of an Intelligent Transportation Model to Enhance Road Safety in Thailands Eastern Economic Corridor.

The development of an intelligent transportation model to strengthen road safety in Thailands Eastern Economic Corridor (EEC) requires a systematic and multidimensional perspective. A review of the literature indicates that one of the major underlying problems is insufficient law enforcement, which allows high-risk behaviors–such as speeding, drunk driving, and the neglect of helmet and seatbelt use–to persist. Enhancing the effectiveness of legal measures is therefore a critical starting point for reducing accident rates. For example, Singapore demonstrates that strict enforcement contributes to significantly lower road fatality rates compared with many countries in the region [14].

Beyond legislation, road infrastructure plays a crucial role. Safety-focused design–such as dedicated lanes for motorcycles and pedestrians, adequate lighting, and the installation of crash barriers–can substantially reduce risks associated with the physical environment [4]. With regard to vehicles, establishing strong safety standards is essential. Basic safety systems such as ABS brakes, airbags, and collision prevention technologies significantly reduce the likelihood of fatality when accidents occur. Additionally, regular and strict vehicle maintenance is fundamental. Proper inspection reduces accidents caused by mechanical failure or vehicle overloading [15].

Emergency response systems must also be rapid and efficient in order to save lives during critical moments. Developing a comprehensive and modern emergency medical network is therefore a key measure that must be implemented in parallel [12]. Equally important is accurate data collection and monitoring. If Thailand can establish a reliable and up-to-date accident database, it will enable more precise identification of high-risk areas and more effective policy interventions [4].

Public education and awareness campaigns remain central components of long-term behavioral change [9]. These efforts should specifically target risky behaviors such as mobile phone use while driving and alcohol-impaired driving, which continue to contribute significantly to accident rates [1]. Finally, promoting intelligent transportation systems and accessible, high-quality public transit can reduce dependence on private vehicles–resulting in smoother traffic flow, reduced congestion, and lower accident risk [7, 8].

The safety concepts discussed in the literature directly informed the design elements proposed in this study. For instance, vehicle safety systems such as Anti-lock Braking Systems (ABS) and collision prevention technologies support the need for adequate stopping distances and clear lane markings in high-speed corridors. International standards on reflective lane markings and median treatments guided the redesign of Highway No. 344 to enhance driver perception and reduce lane-changing conflicts. Furthermore, smart transportation system technologies–such as smart cameras and real-time monitoring–were integrated into the proposed designs to address enforcement gaps and improve incident detection. These elements collectively bridge theoretical safety concepts with the practical design outcomes presented in the results section.

The proposed designs incorporate measurable safety parameters aligned with international standards. Traffic lanes were designed with a standard width of 3.5 meters, while shoulders were maintained at a minimum width of 2 meters to allow emergency stopping. Visibility distances were enhanced to exceed 150 meters on straight sections, improving driver reaction time at high speeds. Energy-efficient LED street lighting was installed at intervals of approximately 8-10 meters, providing an average illumination level of 30-35 lux, consistent with urban arterial road standards. Reflective lane markings, each 10 cm wide and spaced 15 cm apart, were applied to improve nighttime visibility. Crash cushions were positioned at median noses and lane-reduction points with a spacing of 20-30 meters in high-risk zones. Based on previous studies, these combined measures are expected to reduce accident risk by approximately 20-30% in comparable highway environments.

3. Research Methodology

This study employed a design-based and case-oriented research approach to develop a smart transportation model for enhancing road safety in the Eastern Economic Corridor (EEC). The methodology consisted of four main stages. First, secondary data were collected from official policy documents related to road safety in Thailand and Singapore. Second, three representative road sections along Highway No. 344 were purposively selected based on (1) high accident frequency, (2) strategic importance for logistics and industrial access, and (3) variation in road geometry (straight section, T-intersection, and four-way intersection). Third, Singapores road safety standards were systematically reviewed and adapted to the Thai context, focusing on lane configuration, traffic control devices, lighting systems, and smart transportation technologies. Design scenarios were developed using SketchUp Pro to visualize infrastructure improvements and safety features. Finally, an analytical framework was applied to evaluate the proposed designs by comparing pre- and post-design safety conditions, compliance with international standards.

4. Results

Section 1: The research team applied Singapores existing road safety measures–which emphasize continuous road standard monitoring and quality assurance–to the design of a safer road infrastructure within Thailands Eastern Economic Corridor (EEC). Highway No. 344 was selected as the prototype, particularly the straight road section before the Nong Prue intersection in Chonburi Province (as shown in Figure 1). This segment is notable for its expansion from six to ten lanes. The researchers designed the road with the following key components:

- A 2-meter-wide shoulder and 3.5-meter-wide traffic lanes.
- Installation of energy-efficient streetlights every 8 meters to ensure adequate illumination.
- Installation of intelligent cameras at the point where the roadway narrows from five lanes to three, identified as a high-risk area for accidents.
- “SLOW” markings printed along the roadside to enhance driver awareness.
- Use of crash cushions to absorb impact forces and reduce accident severity.
- Original single white lane markings replaced with double yellow reflective lines, each 10 cm wide and spaced 15 cm apart.
- This road design approach is commonly applied to intersections, highways, and major arterial roads.
- The median strip is designed with alternating yellow-and-black patterns (see Illustration A1).



Figure 1: Aerial view of the straight road design.

Implementing appropriate road safety measures and maintaining safety equipment properly can significantly reduce accidents. In addition, the use of zigzag road markings along the median enhances driver awareness, as illustrated in Figure 2.



Figure 2: Side view of the straight road design.

Section 2: The research team developed a road section near the Rojana Industrial Park in Nong Yai District, using Highway No. 344 as the design model. This road serves as the main access route to the Rojana Industrial Park, located in Nong Yai, Chonburi Province. The design incorporates lane markings and road shoulder delineations, as illustrated in Figure 3.



Figure 3: Aerial view of the intersection design at the entrance of Rojana Industrial Park, Nong Yai.

The research team examined the design of an effective bus stop to facilitate passenger travel. The key design features include:

- A solid red reflective line, 10 cm in width, used to mark the traffic lane.
- Double yellow lines with reflective edge lights along the left boundary of the roadway.
- Installation of intelligent cameras at turning points and bus boarding areas to cover high-risk accident zones, as shown in Appendix (Figure A2).
- Additionally, the bus stop area is marked with a 10-cm-wide border outlining the designated bus parking zone. A sidewalk with black-and-white curb markings is provided, along with reflective posts installed at the bus stopping point, as illustrated in Figure 4.



Figure 4: Bus stop design.

Figure 5 illustrates safety treatments applied at the industrial estate entrance, where traffic deceleration and directional changes are required. Zigzag markings along the median are used as a visual guidance tool to emphasize lane discipline and alert drivers to potential crossing movements near access points. This marking pattern helps guide driver attention toward the road centerline, reducing improper overtaking and sudden lane shifts. Combined with double solid yellow lines and enhanced lighting, the design reinforces traffic order and improves driver compliance in transition zones between highway segments and industrial access roads. These measures are particularly effective in mitigating rear-end and side- impact collisions in areas with frequent vehicle entry and exit.



Figure 5: Entrance area of Rojana Industrial Park, Nong Yai.

Section 3: The intersection of Highway 344 at Nong Suea Chang in Chonburi Province is a major junction with heavy traffic volume and is located near a residential area. The research team redesigned this intersection by adapting Singapores road design principles to suit the Thai context. The key design features are as follows:

- A yellow X-shaped box marking at the intersection.
- The main road features double dashed lines with a 5-meter gap between them, allowing a safe stopping distance at red lights due to high traffic volume.
- The secondary road intersecting the main road also has double dashed lines, but with a 3-meter spacing.
- Installation of large floodlights to provide adequate illumination from all directions.
- Installation of high-resolution smart cameras at high-risk points to enhance safety.
- Crash cushions installed around the central median on all four sides, as shown in the Appendix (Figure A3).

Key factors contributing to accidents include vehicle collisions, driver compliance with traffic regulations, visibility conditions, and road alignment. Therefore, appropriate traffic management is essential to prevent and mitigate the severity of accidents involving large trucks, as illustrated in Figure 6.



Figure 6: Aerial view of the Nong Suea Chang intersection.

The community bicycle lane is designated in red, with a width of 3 meters, and runs parallel to the pedestrian walkway for a length of 3 meters. Clear bicycle lane signage is provided, along with a “SLOW” logo painted on the lane. Five warning stripes, each 10 cm wide, are marked across the lane to alert cyclists to watch for pedestrians crossing the road. Additionally, energy-efficient lighting is installed to ensure adequate visibility, and intelligent cameras are placed at high-risk points near pedestrian crossings, as illustrated in Figure 7.

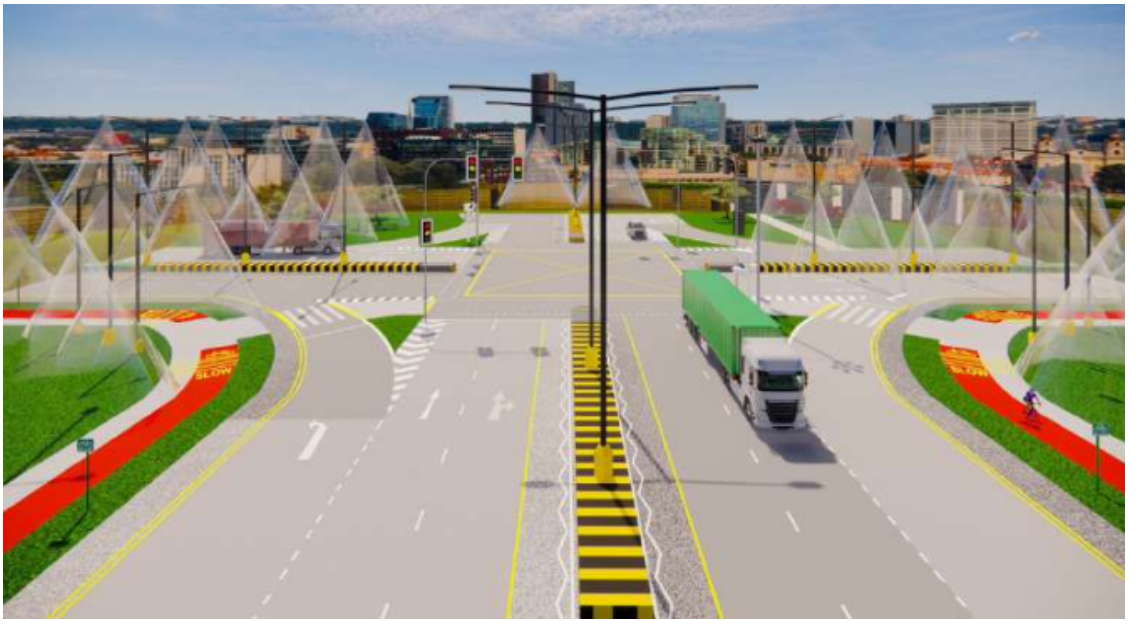


Figure 7: Bicycle lane at the Nong Suea Chang intersection.

In conclusion, figures 6 and 7 demonstrate the redesigned four-way intersection and adjacent bicycle lane at Nong Suea Chang, an area with high traffic density and proximity to residential zones. The yellow X-shaped box marking at the intersection functions to prevent intersection blocking, ensuring continuous traffic flow and reducing collision risks during peak periods. The spacing of dashed lane markings and the installation of high-intensity floodlighting improve stopping visibility and driver reaction time, particularly for heavy vehicles. In Figure 7, the dedicated bicycle lane–clearly marked in red with warning stripes and signage–serves to separate vulnerable road users from motorized traffic. This spatial separation, combined with intelligent camera placement near pedestrian crossings, is expected to significantly reduce conflicts between cyclists, pedestrians, and vehicles, thereby enhancing overall intersection safety.

5. Discussion

Singapore is widely recognized as the country with the most advanced transportation system in Southeast Asia, particularly in terms of management efficiency and safety measures. The country employs a multimodal transport system to connect with key ASEAN member states. Singapores achievements serve as a leading model for exceptional infrastructure and road system management in Asia. The Land Transport Authority (LTA) has developed an integrated and user-friendly road maintenance program that covers pavement restoration, sidewalks, traffic signs, pedestrian bridges, and the installation of energy-efficient street lighting. Any damaged infrastructure must be repaired within 24 hours of receiving a report. In addition, the LTA actively monitors and inspects areas with high accident rates. Regarding Thailand, the construction and expansion project of Highway 344–from Ban Bueng District to Highway 331 (Nong Prue)–as well as the development of the Nong Chak overpass in Chonburi Province aim to improve travel efficiency and logistics connectivity. However, Iamtrakul et al. [10] highlight the importance of utilizing geoinformation systems and spatial analysis to further enhance transportation effectiveness. Moreover, many areas in Thailand, particularly major urban centers, continue to experience frequent road accidents. This underscores the urgent need for research to identify best practices for risk prevention and reduction, as well as to develop more effective safety strategies [11].

The findings of this study are consistent with previous research in Thailand and international contexts, which emphasizes that integrated infrastructure design and smart transportation systems significantly improve road safety outcomes. Compared with earlier Thai studies that focused primarily on enforcement or driver behavior, this research demonstrates the added value of combining physical design improvements with ITS technologies. In the long term, the proposed model supports safer mobility in the EEC by reducing accident-related disruptions to logistics flows and enhancing the reliability of transport networks. The effectiveness of the proposed model is justified by its alignment

with international best practices, empirical evidence from comparable regions, and its adaptability to Thailands strategic economic corridors.

6. Conclusion

For this case study, the focus is on Highway 344, which connects Chonburi Province to Rayong Province over a distance of more than 102 kilometers. This road serves as a major economic corridor for Thailands land-based logistics and contains several key design features that significantly influence driver behavior. However, addressing road safety issues within the Eastern Economic Corridor cannot rely on any single measure. A holistic approach is required–spanning law enforcement, infrastructure development, vehicle standards, emergency response systems, data collection and monitoring, public awareness campaigns, and investment in intelligent transportation systems, as illustrated in Figure 8. If these measures are implemented effectively, Thailand will be able to reduce accidents, create a safer society, and sustainably improve the quality of life for residents within the Eastern Economic Corridor [5].

The proposed smart transportation model can be implemented through a phased roadmap. In the short term, priority should be given to improving lane markings, installing reflective signage, and upgrading lighting systems at high-risk locations. In the medium term, intelligent transportation systems–such as smart cameras, traffic monitoring sensors, and data integration platforms–should be expanded to strengthen enforcement and incident management. In the long term, the EEC should move toward multimodal system integration, supported by a centralized smart command center that coordinates traffic control, emergency response, and logistics management across the region.

However, this study has some limitations. First, the proposed designs are based primarily on simulated and visualized data rather than post-implementation crash records. Second, the adaptation of Singapores road safety standards may not fully reflect Thai driving behavior and compliance patterns. Third, the analysis did not incorporate detailed hourly traffic volume data due to data availability constraints. Finally, the accident dataset used in this study was limited to officially reported cases, which may underestimate minor or unreported incidents. These limitations suggest the need for further empirical validation following real-world implementation.



Figure 8: Development of the smart transportation model.

7. Appendix A: Additional details on the road design

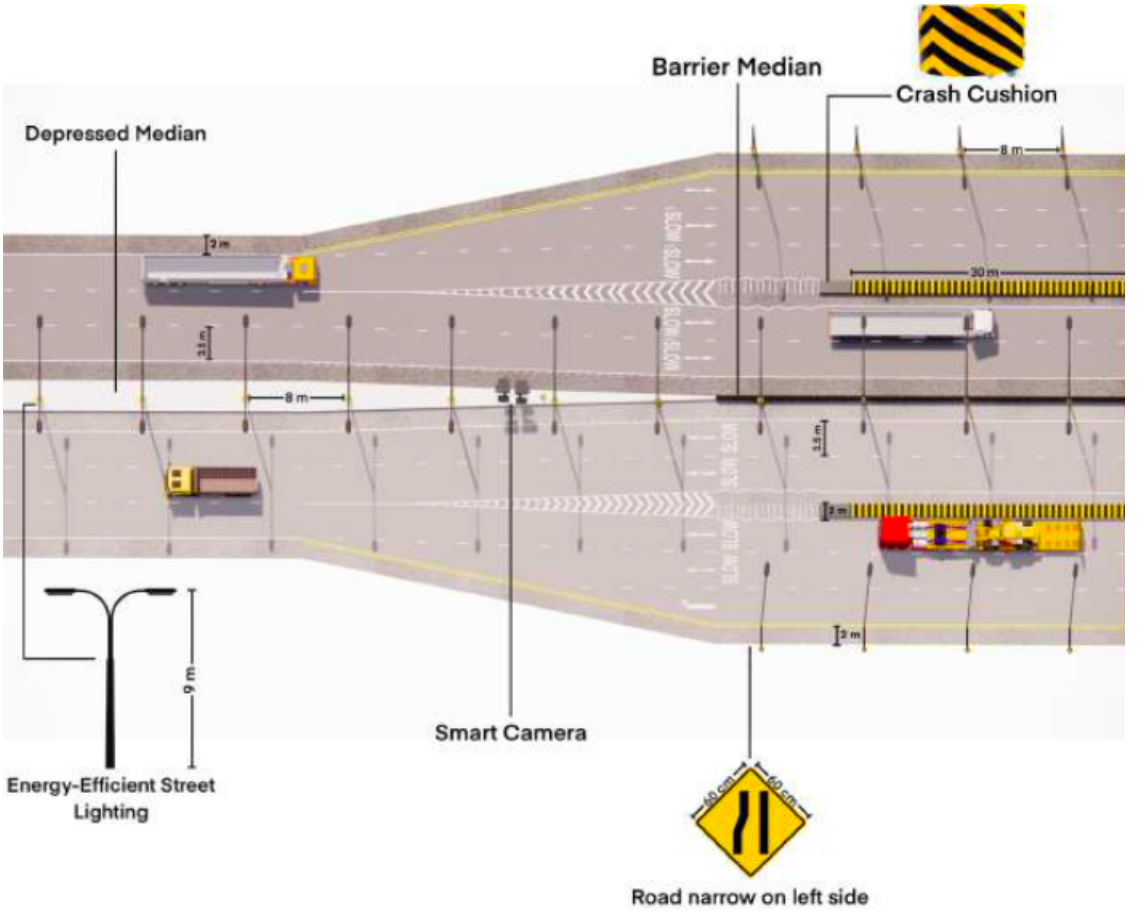


Figure A1: Additional details of the straight road section.

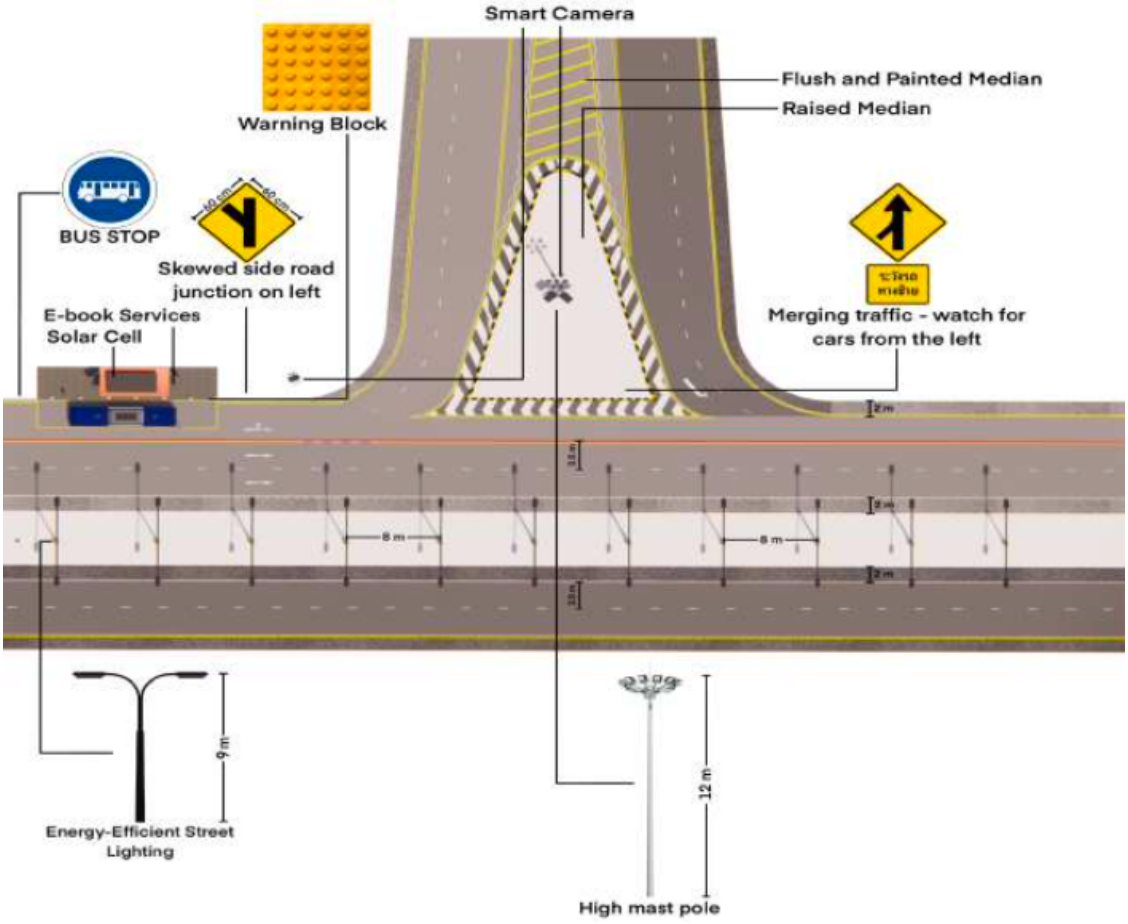


Figure A2: Additional details of the T-intersection.

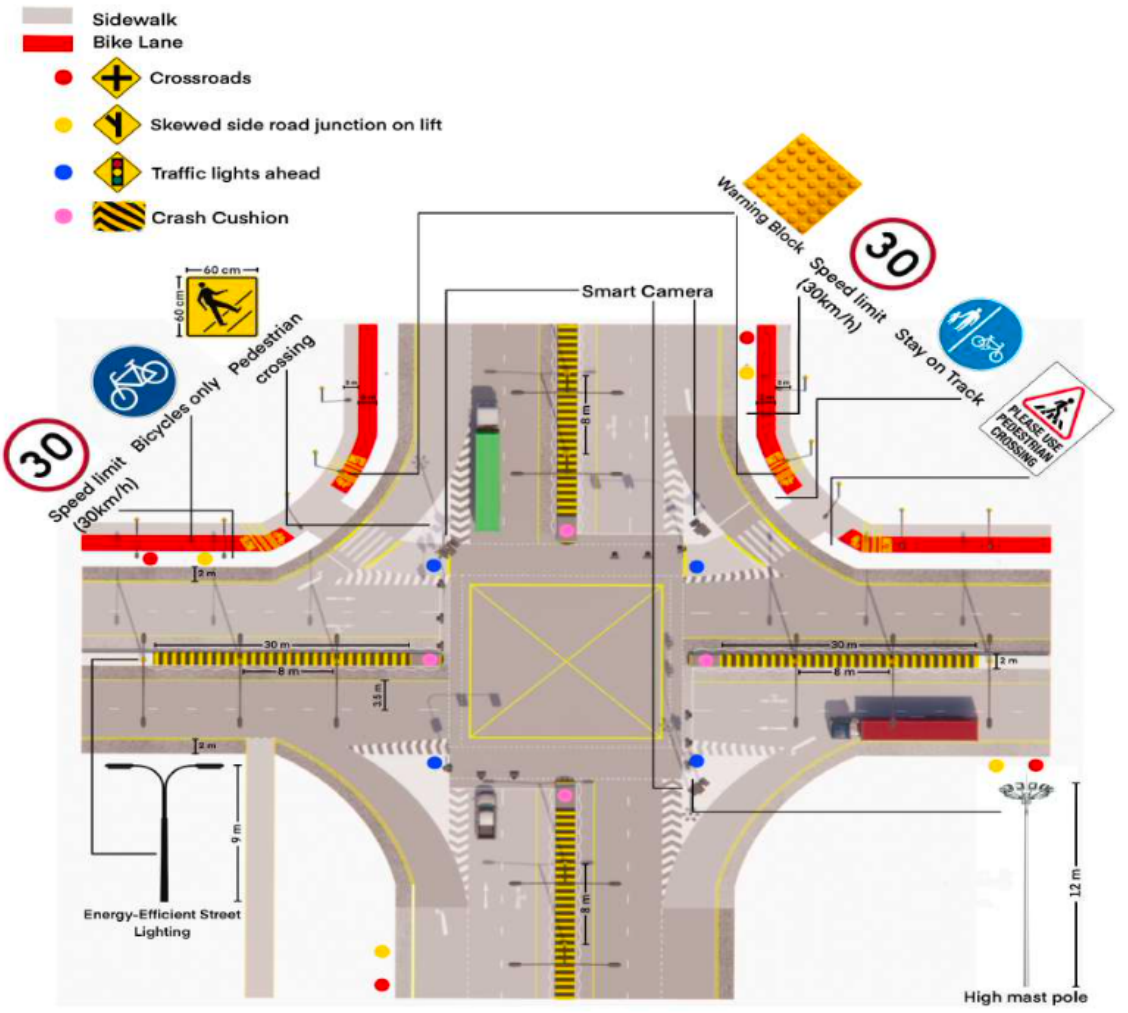


Figure A3: Additional details of the four-way intersection.

Declaration of competing interest

The authors declare that they have no affiliations with or involvement in any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript.

Author Contributions

Jakkawat Laphet: Design research, methodology, software, validation, formal analysis, investigation, data curation, writing - original draft preparation, writing - review and editing.

Dultadej Sanvises: writing - original draft preparation, writing - review and editing, Project administration, Summarize results, Provide Recommendations.

Waraphon Klinsreesuk: Design research, methodology, software, validation, formal analysis.

Tapsatit Gooncokkord: Project administration, Summarize results, Provide Recommendations.

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