RJEST Research Journal of Education Science & Technology
Volume 4, Number 1 (2024)
ISSN: 2783-0225
www.rjest.org

Research Article

OPEN ACCESS

DrivePal: Real-Time Road Safety Monitoring and Traffic Violation Reporting Using Geofencing Technology

Louther Jan C. Adarle[a], Kenneth Brian G. Mallo[a], and Johnedel S. Mapa[a]

[a]College of Information Technology, University of Negros Occidental-Recoletos, Bacolod City, 6100, Philippines

ARTICLE INFO

Corresponding Author:
Louther Jan C. Adarle
Email: ljadarle@gmail.com

Article History
Received: June 23, 2024
Revised: Sept 03, 2024
Accepted: Dec 10, 2024

Keywords
Geofencing,
Road Safety,
Traffic Violation Reporting,
Mobile Application,
Smart Traffic Management

DOI
10.63179/rjest.v4i1.48

ABSTRACT

Amidst the increasing trend of the statistical data on injuries and deaths caused by vehicular accidents, current traffic monitoring solutions remain reliant on manual enforcement, which is prone to human error, limited coverage, and delayed reporting. To address these challenges, this study introduces DrivePal, a mobile application designed to provide real-time road safety monitoring and automated traffic violation reporting using geofencing technology. By employing agile methodology, this study implemented user-centered design principles and integrate geospatial algorithms. DrivePal utilizes Google Maps APIs for navigation, Firebase for real-time database management, and custom Android-based interfaces to enhance user interaction. Thirty end-users participated in the evaluation of the application by completing a survey based on Boehm's and McCall's software quality models. Results revealed that DrivePal demonstrated high accuracy in speed detection (93%), perfect success in violation reporting (100%), and very high overall usability (97%). These findings suggest that DrivePal is an effective solution for enhancing road safety by proactively alerting motorists and enabling traffic authorities to monitor traffic violations in real time.

1. INTRODUCTION

Road traffic accidents continue to be a major global public health concern, accounting for significant loss of life, injuries, and economic costs each year. According to international road safety studies, excessive speed, improper lane usage, and non-compliance with traffic regulations remain among the leading contributors to vehicular crashes, particularly in urban environments with dense traffic flows (Elvik, 2012; World Health Organization [WHO], 2018). Despite advances in transportation planning and policy, many cities, especially in developing regions, still rely heavily on manual traffic enforcement, which is constrained by limited manpower, incomplete spatial coverage, delayed reporting, and vulnerability to human error (Oviedo-Trespalacios et al., 2016).

The rapid evolution of intelligent transportation systems (ITS) has opened new avenues for addressing these limitations through data-driven, real-time monitoring solutions. ITS integrates information and communication technologies with transportation infrastructure to improve road safety, traffic efficiency, and enforcement effectiveness (Ezell et al., 2010). Mobile computing, cloud platforms, and location-based services have become particularly influential in extending ITS capabilities beyond fixed roadside infrastructure, enabling continuous vehicle monitoring using consumer-grade devices (Engelbrecht et al., 2015).

Recommended Citation: Adarle, L.C., Mallo, K.G., & Mapa, J.S. (2024). DrivePal: Real-Time Road Safety Monitoring and Traffic Violation Reporting Using Geofencing Technology. *Research Journal of Education, Science and Technology*, *4*(1), pp. 45-54. https://doi.org/10.63179/rjest.v4i1.48.

Among location-aware technologies, geofencing has gained increasing attention for its ability to define virtual geographic boundaries and trigger automated system responses when those boundaries are crossed. In transportation contexts, geofencing has been applied to speed control, restricted-zone enforcement, fleet management, and safety-critical alerts (Ghouri, 2020). When combined with GPS-based speed estimation, geofencing enables contextual interpretation of driving behavior relative to road type, traffic rules, and environmental constraints (Binjammaz et al., 2016). Research has shown that GPS-derived speed measurements can achieve accuracy comparable to or exceeding that of conventional vehicle speedometers under appropriate conditions (Damsere-Derry et al., 2022; Zhao et al., 2018).

Despite these technological advances, most commercially available navigation and traffic applications focus primarily on route optimization and congestion visualization, offering limited support for proactive enforcement or automated violation documentation. Existing systems often rely on user self-awareness or manual reporting mechanisms, which reduces their effectiveness in ensuring sustained compliance with traffic regulations (Aghayari et al., 2021). Furthermore, many solutions are designed for global applicability and fail to incorporate localized traffic ordinances, enforcement workflows, and behavioral considerations, which are critical for real-world deployment and policy integration at the city level (Elassy et al., 2024).

To address these gaps, this study introduces DrivePal, a mobile application that supports real-time road safety monitoring and automated traffic violation reporting via geofencing technology. Unlike conventional navigation tools, DrivePal emphasizes preventive road safety by combining visual, audio, and haptic alerts and incorporating design strategies to minimize driver distraction, an increasingly recognized factor in traffic accident causation (Oviedo-Trespalacios et al., 2016).

2. RELATED SYSTEMS

Table 1 presents a comparative summary of DrivePal and existing traffic monitoring applications based on four key criteria: road safety and security, road safety reporting, safe mode, and experience localization. It highlights DrivePal's strengths in integrating geofencing-based safety alerts, automated violation reporting, and distraction-minimization features within a localized context.

Table 1. Review of Related Systems.

Criteria \ Systems	DrivePal	GPS Speedometer	Traffic Spotter	Kyrus Fleet
Road Safety and Security	✓	✓	✓	✕
Road Safety Reports	✓	✕	✕	✕
Safe Mode	✓	✕	✕	✓
Localized	✓	◖	◖	◖

Note: ✓ = supported; ◖ = partially supported; ✕ = not supported.

2.1 *Road Safety and Security*

Road safety and security remain fundamental objectives of ITS, particularly in urban places where traffic density and rule violations are prevalent (Kielek, 2022; Joewono & Kubotam, 2006). Existing applications approach road safety primarily through informational awareness rather than preventive enforcement (Ehsani et al., 2023; Safarpour et al., 2020). GPS Speedometer, for instance, focuses on displaying real-time speed, distance, and route information to motorists. While such functionality supports driver awareness, it does not proactively enforce compliance with road-specific rules such as zone-based speed limits or one-way road restrictions (Serrone et al., 2023). TrafficSpotter, on the other hand, emphasizes traffic flow visualization, incident reporting, and weather-based traffic forecasting. Although these features enhance situational awareness for drivers and travelers, they are primarily designed for congestion avoidance and travel planning rather than direct road-safety enforcement (Shaygan et al., 2022). KyrusFleet offers fleet-oriented management features but does not provide interactive road safety alerts or rule-based monitoring for individual motorists. In contrast, DrivePal strengthens road safety and security by integrating interactive mapping with geofencing-based zone alerts (Weibull et al., 2024; Nayak et al., 2019). The application proactively notifies motorists through visual, audio, and haptic feedback when entering speed-regulated zones or approaching one-way roads. This preventive approach transforms road safety from a passive information system into an active compliance mechanism, enhancing situational awareness during driving.

2.2 *Road Safety Report*

A critical limitation of many existing traffic applications is the lack of an automated road-safety reporting mechanism (Ehsani et al., 2023). GPS Speedometer and TrafficSpotter do not support traffic violation reporting; they function primarily as driver-assist tools without enforcement linkage. Any violations that occur while using these applications remain undocumented unless traffic enforcers are physically present, reinforcing reliance on manual enforcement systems. Similarly, KyrusFleet does not support automated reporting of traffic violations under standard driving conditions. DrivePal addresses this significant gap by introducing automated traffic violation reporting, a feature absent in all three compared systems. When a confirmed violation (e.g., over-speeding or wrong-way driving) occurs, DrivePal automatically generates a structured report containing vehicle details, user information, violation type, location, and timestamp. These reports are transmitted to an administration dashboard intended for real-time monitoring and post-event analysis.

2.3 Safe Mode

Driver distraction is widely recognized as a major contributor to road accidents, yet many traffic applications overlook this factor (Cuentas-Hernandez et al., 2024; Ehsani et al., 2023). GPS Speedometer and TrafficSpotter allow unrestricted notifications while driving. KyrusFleet implements a safe mode that disables texting and certain distracting applications. While this feature contributes to safer driving behavior, it is implemented as a standalone control mechanism and is not tightly integrated with navigation, alerts, or enforcement functionalities. DrivePal expands upon the safe mode concept by implementing a Drive Mode that systematically minimizes distractions during navigation. The application suppresses notifications from common social and media applications while simultaneously providing quick-call access to pre-registered emergency contacts. This design ensures that essential communication remains accessible without exposing the driver to unnecessary interruptions.

2.4 Localized

Most widely available traffic applications prioritize global coverage, often at the expense of contextual relevance. GPS Speedometer, Traffic Spotter, and KyrusFleet are designed for worldwide use and rely on generalized traffic data and road information. While this broad scope supports scalability, it limits the system's ability to reflect local traffic ordinances, enforcement practices, and road-specific conditions.

DrivePal adopts a fundamentally different design philosophy through experience localization. The application is specifically designed for Bacolod City, with road zones, speed limits, and one-way streets mapped in accordance with local traffic regulations. More importantly, its reporting mechanism is aligned with the local enforcement structure, ensuring that detected violations are contextually meaningful and administratively actionable. This localized approach enhances practical deployment, accuracy, and policy relevance. Rather than offering generic guidance, DrivePal delivers context-aware safety interventions tailored to the city's actual road environment. Such localization is a critical advantage for urban traffic management systems, particularly in cities.

3. METHODOLOGY

3.1 Research Design

The study employed a developmental and evaluative research design, combining agile software development with quantitative user-based evaluation. The developmental phase focused on the iterative design and implementation of DrivePal using user-centered design principles, while the evaluative phase assessed the software quality attributes based on end-user feedback. An agile methodology was selected to enable continuous feature refinement, rapid prototyping, and incremental validation of system requirements, ensuring the application responded effectively to functional requirements for road safety alerts, violation detection, reporting mechanisms, and distraction minimization.

3.2 Product Decomposition

To ensure scalability, DrivePal was decomposed into three modules, as shown in Figure 1.

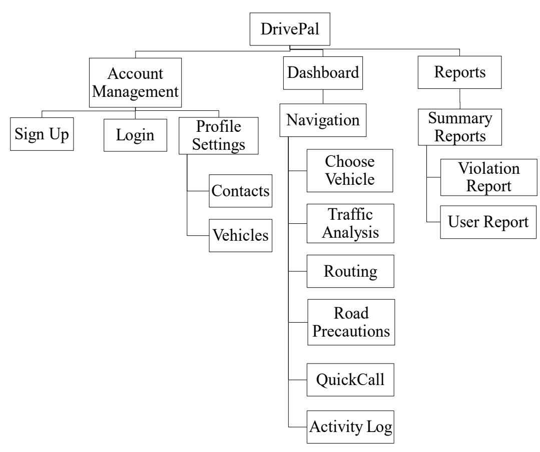


Figure 1. DrivePal Decomposition Chart.

The Account Management module manages user registration, authentication, profile settings, vehicle registration, and emergency contact configuration. It ensures user validation and data integrity by associating violation records with verified users and registered vehicles. On the other hand, the Navigation and Safety Monitoring module handles real-time navigation, GPS-based speed monitoring, geofencing detection, and safety alerts. It is responsible for detecting predefined traffic zones (e.g., speed-limited areas and one-way roads) and issuing preventive warnings through visual, audio, and haptic feedback. Meanwhile, the Reporting and Administration module automatically generates traffic violation reports upon confirmed rule violations and synchronizes them with a web-based administration dashboard. It enables authorized personnel to view, manage, and export violation records for monitoring and analysis.

3.3 Hardware Platform

The development and testing of DrivePal required both computer and mobile hardware platforms. The specifications are listed in Table 2.

Table 2. Hardware Specifications.

Category	Specification
Computer Devices	
Processor	Inter Core i5
Memory Capacity	8 GB RAM or more
Storage Capacity	500 GB or more
Mobile Devices	
Screen Size	5 inches or higher
Memory Capacity	1 GB RAM or higher
Storage Capacity	1 GB ROM free or higher
Connectivity	Wireless or Cellular Data

For development and administration, a computer unit with a minimum specification of an Intel Core i5 processor, 8 GB RAM, and at least 500 GB of storage was used to support integrated development environments, design tools, and database management. For deployment and testing, Android mobile devices with a minimum screen size of 5 inches, at least 1 GB RAM, and sufficient storage were utilized. Wireless or cellular internet connectivity was required to support real-time navigation, GPS data acquisition, and cloud-based synchronization.

3.4 Operating System

DrivePal is an Android-based mobile application that supports Android 4.4 (KitKat) to 5.1 (Lollipop). This version range was selected to maximize device compatibility while maintaining access to essential location and sensor APIs. The administration dashboard was accessed through standard web browsers running on Windows-based operating systems (Windows 8 and above). Internet connectivity was required to enable real-time data exchange.

3.5 Software Tool

Several software tools and platforms were utilized during the development of DrivePal. These tools supported efficient development, real-time data handling, and user-friendly interface design. Android Studio served as the primary integrated development environment for building the mobile application, using Java-based Android development frameworks. Firebase Realtime Database was used for cloud-based data storage and synchronization, enabling real-time updates of user data, navigation records, and violation reports. Google Maps APIs were integrated to support navigation, traffic analysis, route optimization, and geospatial mapping. Visual Studio and PHP were used to develop the web-based administration dashboard for traffic authorities. Adobe XD and Adobe Photoshop were employed for user interface design, prototyping, and visual asset creation.

3.6 Evaluation

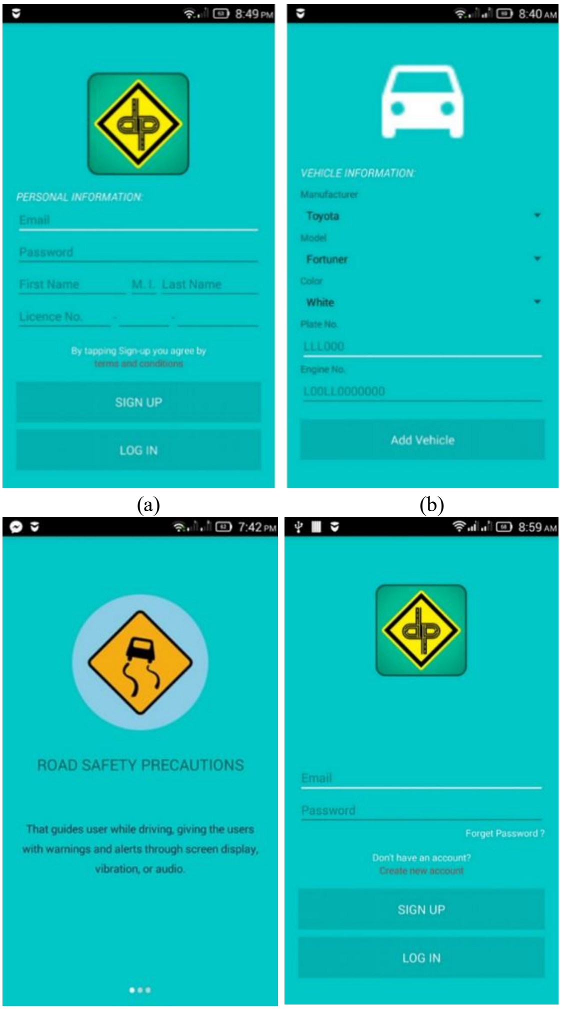
The evaluation phase focused on assessing the software quality and functional effectiveness of DrivePal. A total of 30 end users participated in the evaluation, representing licensed motorists in the application’s deployment area. A structured survey instrument was developed based on Boehm’s Software Quality Model and McCall’s Software Quality Factors, covering key attributes such as accuracy, completeness, consistency, operability, usability, and reliability. Respondents interacted with the application and subsequently rated its performance using predefined criteria.

Descriptive statistical analysis was used to summarize evaluation results. The findings provided empirical evidence of the system’s performance, supporting the validation of DrivePal as a reliable and effective road safety monitoring solution. Quantitative metrics were computed to evaluate the accuracy of GPS-based speed detection and location monitoring, the effectiveness of automated violation reporting, and overall usability and user experience.

4. DRIVEPAL USER INTERFACES

4.1 Signup and Login Forms

The Signup and Login Forms serve as the primary access points to the DrivePal system, as shown in Figure 2. The signup interface allows new users to create an account by providing essential personal and vehicle-related information, including full name, email address, license number, password, and vehicle details such as manufacturer, model, plate number, and engine number. This information ensures proper user identification and establishes the basis for associating traffic violations with specific drivers and vehicles.



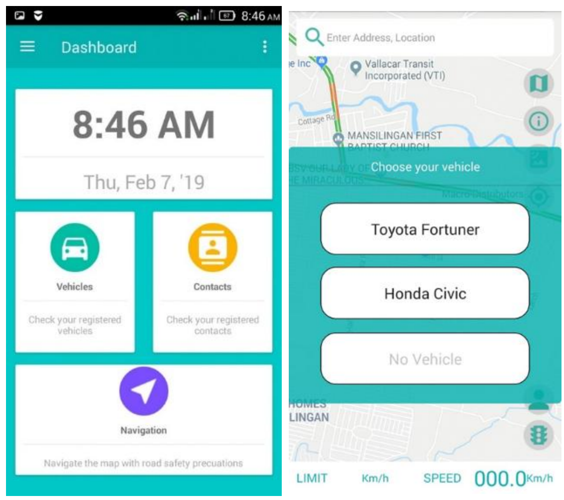
(a) (b) (c) (d)

Figure 2. Signup[ab], Landing[c], and Login[d] Interfaces.

The login interface enables registered users to securely access the application using their credentials. Input validation and error-handling mechanisms are implemented to prevent incomplete or invalid entries. These forms prioritize simplicity and clarity to reduce onboarding friction while maintaining data integrity and security. By requiring authentication before access, DrivePal ensures that only verified motorists can utilize its safety and reporting features.

4.2 *Dashboard*

The Dashboard functions as the central control hub of the DrivePal application, as shown in Figure 3(a). Upon successful login, users are directed to this interface, which provides quick access to core features such as vehicle management, contact settings, navigation, and activity logs. The dashboard displays essential contextual information, including the current date and time, reinforcing situational awareness. The layout is intentionally minimalistic, presenting large, clearly labeled buttons to facilitate quick interaction and reduce distraction. This interface enables users to transition efficiently between modules without navigating through complex menus, supporting safe usage even in time-sensitive situations.



(a) (b)

Figure 3. Dashboard[a] and Vehicles Interfaces[b].

4.3 *Vehicles and Choose Vehicles Interfaces*

The Vehicles interface, as shown in Figure 3(b), allows users to manage one or more registered vehicles associated with their account. Users can add, view, or remove vehicle entries by providing vehicle-specific details. This functionality is critical for ensuring that traffic violation reports are accurately linked to the correct vehicle, especially for users who own multiple cars. The Choose Vehicle interface is displayed prior to initiating navigation. It prompts the user to select the vehicle in use, ensuring that all subsequent monitoring, alerts, and reports correspond to that vehicle. This two-step vehicle management approach enhances data accuracy and reinforces accountability within the reporting mechanism.

4.4 *Navigation*

The Navigation Interfaces, shown in Figure 4, provide users with real-time map-based guidance using interactive mapping features. Users can search for destinations by name or directly pin locations on the map. Once a destination is selected, the system computes the fastest route based on traffic conditions, historical data, and road speed limits. The navigation interface also includes controls for map customization, GPS positioning, traffic visualization, and quick access to emergency contacts. These features are strategically positioned to ensure accessibility without obstructing the map view. The interface balances informational richness with visual clarity, allowing drivers to remain focused on the road.

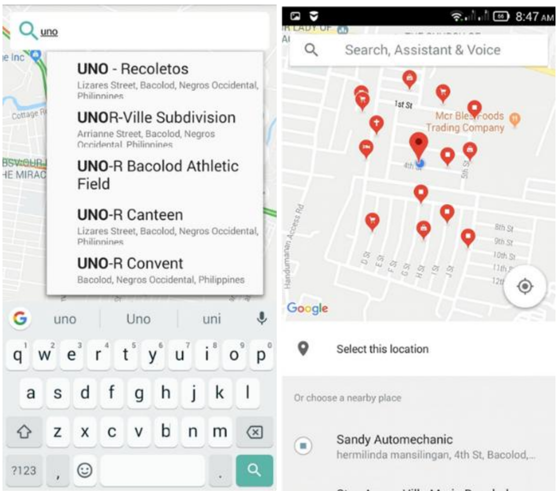
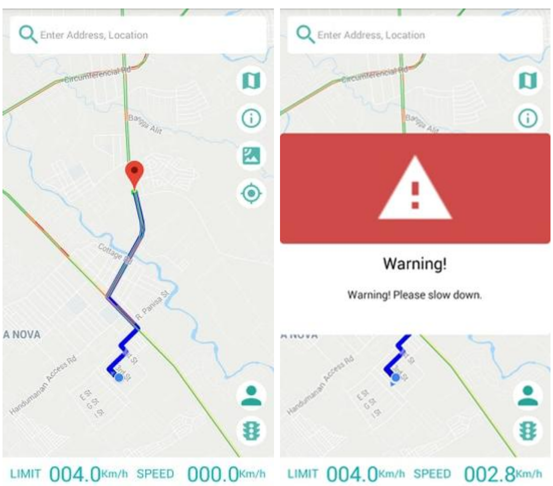


Figure 4. Navigation Interfaces.



(a) (b)

Figure 5. Drive Mode[a] and Road Sign Alert[b].

4.5 *Drive Mode Interface*

The Drive Mode interface, as shown in Figure 5(a), is activated once navigation begins. This interface is optimized for real-time driving conditions and emphasizes road safety through continuous monitoring and alerts. It displays critical driving information, including current speed, applicable speed limits, route progression, and upcoming road conditions. Drive Mode also suppresses unnecessary notifications to minimize distractions. Alerts related to speed violations or one-way road entry are delivered using visual cues, audio signals, and vibration, ensuring that drivers receive warnings without diverting attention from the road. This interface embodies DrivePal's preventive approach to road safety by guiding driver behavior in real time.

4.6 *Road Sign Alert Interface*

The Road Sign Alert interface, as shown in Figure 5(b), provides early warnings when drivers approach regulated zones such as speed-limited areas or one-way roads. These alerts are triggered by geofencing and displayed prominently on the screen to ensure visibility. The interface uses color-coded visuals and concise messages to effectively communicate warnings. By notifying drivers before a violation occurs, this interface supports proactive compliance and reduces the likelihood of accidental traffic infractions. If a warning is ignored and a violation is confirmed, the system proceeds to the violation reporting process.

4.7 *Activity Log Interface*

The Activity Log interface, as shown in Figure 6, maintains a chronological record of completed trips. Each entry includes details such as destination, date, and time of arrival. This interface allows users to review their travel history and serves as a personal reference for past journeys. The activity log is accessible via the dashboard and restricted to authenticated users, preserving data privacy.

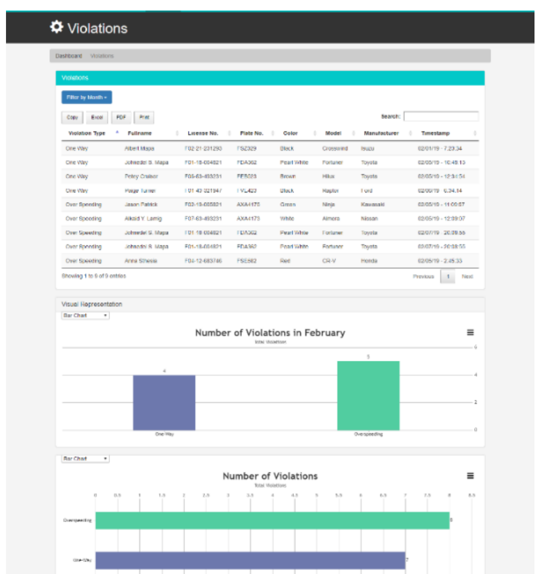


Figure 6. Activity Log Interface.

5. RESULTS

Table 3 summarizes the key results of the evaluation across the major software quality attributes assessed in this study.

Table 3. DrivePal Evaluation Results.

Attribute	Model	Focus	Results
Accuracy	Boehm	GPS-based speed detection and location monitoring	93%
Completeness	Boehm	Implementation of required safety and reporting features	100%
Consistency	Boehm	Task completion and interface uniformity	90%
Operability	McCall	Functional correctness and system response	100%
Usability	McCall	Ease of use, clarity, and interaction efficiency	97%
Violation Reporting Success	System Performance Metric	Automated report generation and transmission	100%

Accuracy is a critical attribute for road safety systems, particularly those that rely on GPS data to detect speed-related violations. The evaluation results indicate that DrivePal achieved a 93% accuracy rate in GPS-based speed detection and location monitoring. This result suggests that the system can reliably compute vehicle speed using distance-over-time calculations based on GPS coordinates. Minor inaccuracies were observed in a small number of test cases, primarily in areas with weak satellite signals or intermittent connectivity. However, these occurrences did not significantly affect the system's overall functionality or its ability to issue warnings and generate reports. The achieved accuracy level is considered acceptable for real-time mobile road-safety applications and supports the reliability of DrivePal's violation-detection mechanism.

One of the defining features of DrivePal is its automated traffic violation reporting capability. Evaluation results show a 100% success rate in generating and transmitting violation reports for the supported traffic rules, namely over-speeding and wrong-way driving.

All detected violations were correctly recorded with complete details, including vehicle information, violation type, timestamp, and location, and were successfully synchronized with the administration dashboard. This result confirms that the reporting module functions consistently and serves as a bridge between real-time detection and authority-level monitoring. The absence of reporting failures highlights the robustness of the system's backend integration and real-time data synchronization.

Usability is particularly important for applications intended for use while driving, where excessive interaction can compromise safety. The evaluation yielded an overall usability rating of 97%, indicating very high user acceptance. Respondents reported that the interfaces were intuitive, visually clear, and easy to navigate, even during active driving scenarios. Features such as the simplified dashboard, drive mode, and quick call interface were positively received, as they minimized user interaction while preserving access to essential functions. These findings demonstrate that DrivePal successfully balances functional richness with distraction minimization, a key requirement for mobile road safety systems.

DrivePal demonstrated strong reliability and completeness. The evaluation confirmed that all core functionalities (e.g., safety alerts, navigation, violation detection, and reporting) were fully implemented and operational, resulting in a 100% completeness score for the evaluated modules. Consistency testing showed that 90% of users completed assigned tasks smoothly without encountering interface or navigation issues. A small number of users reported minor layout interpretation difficulties, suggesting opportunities for further interface refinement. Nonetheless, the results indicate that the system maintains a consistent interaction flow across modules.

6. DISCUSSION

The evaluation results provide strong empirical support for DrivePal as an effective mobile-based road-safety monitoring and traffic-violation reporting system. The observed 93% accuracy in GPS-based speed detection indicates that smartphone sensing can yield operationally reliable measurements for road safety applications, consistent with prior research emphasizing the feasibility of smartphone-based sensing for ITS deployments (Engelbrecht et al., 2015). At the same time, the literature cautions that GPS-derived measurements are sensitive to integrity issues (e.g., signal obstruction, multipath effects, and intermittent connectivity), highlighting the importance of context-aware monitoring and quality assurance mechanisms. In this study, the small proportion of inaccurate readings aligns with these established limitations of GPS-based transportation data and supports the interpretation that DrivePal's performance is robust but not immune to environmental constraints (Binjammaz et al., 2016; Zhao et al., 2017).

Notably, DrivePal achieved a 100% success rate in automated violation reporting, demonstrating high system reliability in converting detected infractions into actionable, time-stamped records. This capability directly responds to broader calls for strengthening enforcement and monitoring as part of effective road safety governance, where speed control and timely intervention remain among the most evidence-supported approaches for reducing crash risk (Elvik, 2012; Safarpour et al., 2020). From a system perspective, DrivePal also advances the practical direction of ITS in smart cities by coupling real-time geospatial detection with cloud-enabled reporting, which is a pattern increasingly identified as essential for sustainable, scalable traffic management (Elassy et al., 2024). Compared to many mobile road safety apps, DrivePal's automated reporting function operationalizes enforcement support, thereby addressing a frequently noted gap between "risk recognition" and "institutional action" in mobile road safety interventions (Aghayari et al., 2021; Ehsani et al., 2023).

DrivePal's preventive safety workflow (i.e., early alerts followed by automatic reporting if noncompliance persists) also aligns with the growing body of work demonstrating the value of geofencing as a proactive safety mechanism. Geofencing-based interventions have been proposed and tested for collision avoidance and safety-critical warnings, particularly in constrained or high-risk zones (Nayak et al., 2019; Weibull et al., 2024). DrivePal's design similarly leverages zone logic to encourage compliance before a violation becomes an incident, reinforcing the view that real-time, context-triggered interventions can complement conventional enforcement strategies (Elvik, 2012; Safarpour et al., 2020). In addition, DrivePal's reliance on GPS-based speed sensing has practical implications in contexts where vehicle instrumentation can be unreliable; for example, evidence from commercial driving contexts shows that faulty speedometers can undermine safe speed compliance and increase risk, strengthening the case for independent speed validation through GPS-based approaches (Damsere-Derry et al., 2022). While DrivePal is not positioned as a replacement for vehicle instrumentation, the evaluation results suggest it can serve as a meaningful supplementary safety layer, particularly in environments where instrumentation and enforcement coverage are uneven (Damsere-Derry et al., 2022; WHO, 2018).

The high overall usability rating (97%) is especially important given that safety apps can inadvertently add cognitive load if they require frequent interaction. The strong usability outcome supports the premise that driver-facing safety systems must be designed to reduce friction and promote rapid comprehension, a principle repeatedly emphasized in the road safety and human factors literature (Aghayari et al., 2021; Ehsani et al., 2023). Moreover, DrivePal's emphasis on minimizing distractions is consistent with evidence that mobile phone interaction risk is shaped by driving context and that interventions should be sensitive to real-time conditions and attention demands (Cuentas-Hernandez et al., 2024; Oviedo-Trespalacios et al., 2016). In this sense, DrivePal's interface strategy supports the broader recommendation that mobile-based road safety solutions should not merely inform drivers but must also be attention-aware to avoid contributing to distraction-related risk (Cuentas-Hernandez et al., 2024; Oviedo-Trespalacios et al., 2016).

7. CONCLUSION

This study presented DrivePal, a mobile-based road safety monitoring and traffic violation reporting system designed to address persistent limitations of manual traffic enforcement and awareness-oriented navigation applications. By integrating GPS-based speed detection, geofencing technology, and real-time cloud synchronization, DrivePal provides a proactive and localized approach to improving road safety through early warnings, distraction minimization, and automated violation reporting.

The evaluation results demonstrate that DrivePal is technically viable and operationally effective. The system achieved high-speed detection accuracy, perfect reliability in automated violation reporting, and very high usability, indicating that safety-critical mobile applications can be both functionally robust and user-friendly. These findings confirm that smartphone-based sensing, when combined with contextual geofencing and careful interface design, can support real-time enforcementoriented road safety interventions without increasing driver distraction. Compared with existing applications such as Speedometer GPS, Traffic Spotter, and KyrusFleet Application, DrivePal offers a more comprehensive solution by unifying preventive safety alerts, automated enforcement support, safe-mode interaction, and experience localization within a single platform. This integrated design addresses a key gap identified in prior studies: most mobile road safety applications focus on awareness or navigation but lack mechanisms for systematic violation documentation and authority-level monitoring.

While minor limitations were observed, these do not undermine the system's overall effectiveness. Rather, they highlight a well-documented reality in applied ITS deployments: performance and user experience can vary across real-world contexts, devices, and road environments, requiring continued iteration and expanded field testing (Engelbrecht et al., 2015; Ehsani et al., 2023). Future enhancements should therefore prioritize (1) improved GPS integrity handling and contextual validation, and (2) broader on-road testing across more diverse traffic environments to strengthen generalizability and resilience. Additionally, given that safety and security perceptions vary across local contexts in developing settings, DrivePal's localized implementation can be leveraged further by integrating user and authority feedback to improve perceived legitimacy, trust, and adoption.

ACKNOWLEDGMENT

The researchers would like to express their sincere gratitude to Elmer T. Haro, Ph.D., for his unwavering patience, guidance, and encouragement throughout the entire development and documentation of this capstone project, continuously motivating the team to achieve their best. They also extend their appreciation to Mr. Ryan G. Gonzales, the technical consultant, for his valuable guidance, supervision, and insightful advice during the application development process.

DECLARATIONS

Conflict of Interest

The authors declare they have no conflict of interest.

Informed Consent

All participants involved in this study were fully informed about the purpose, procedures, and scope of the research prior to their participation. Participation was entirely voluntary, and informed consent was obtained from all respondents. Participants were assured of the confidentiality and anonymity of their responses, and they were informed of their right to withdraw from the study at any time without penalty.

REFERENCES

Aghayari, H., Kalankesh, L. R., Sadeghi-Bazargani, H., & Feizi-Derakhshi, M.-R. (2021). Mobile applications for road traffic health and safety in the mirror of the Haddon's matrix. *BMC Med Informatics and Decision Making*, *21*(1). https://doi.org/10.1186/s12911-021-01578-8

Binjammaz, T. A., Al-Bayatti, A. H., & Al-Hargan, A. H. (2016). Context-aware GPS integrity monitoring for intelligent transport systems. *Journal of Traffic and Transportation Engineering (English Edition)*, *3*(1), 1–15. https://doi.org/10.1016/j.jtte.2015.09.002

Cuentas-Hernandez, S., Li, X., King, M. J., Lewis, I., & Oviedo-Trespalacios, O. (2024). Driven to distraction: A systematic literature review on the role of the driving context in mobile phone use. *Transportation Research Part F: Traffic Psychology and Behaviour*, *106*, 215–243. https://doi.org/10.1016/j.trf.2024.08.006

Damsere-Derry, J., Afukaar, F., Mock, C., & Donkor, P. (2022). Prevalence, precision, and road safety implications of using faulty speedometers among commercial drivers in Ghana. *Urban, Planning and Transport Research*, *10*(1), 358–371. https://doi.org/10.1080/21650020.2022.2093267

Ehsani, J. P., Michael, J. P., & MacKenzie, E. J. (2023). The Future of Road Safety: Challenges and Opportunities. *The Milbank Quarterly*, *101*(S1), 613–636. https://doi.org/10.1111/1468-0009.12644

Elassy, M., Al-Hattab, M., Takruri, M., & Badawi, S. (2024). Intelligent Transportation Systems for Sustainable Smart Cities. *Transportation Engineering*, *16*, 100252. https://doi.org/10.1016/j.treng.2024.100252

Elvik, R. (2012). Speed Limits, Enforcement, and Health Consequences. *Annual Review of Public Health*, *33*(1), 225–238. https://doi.org/10.1146/annurev-publhealth-031811-124634

Engelbrecht, J., Booysen, M. J., Bruwer, F. J., & van Rooyen, G.-J. (2015). Survey of smartphone-based sensing in vehicles for intelligent transportation system applications. *IET Intelligent Transport Systems*, *9*(10), 924–935. https://doi.org/10.1049/iet-its.2014.0248

Ezell, B. C., Bennett, S. P., von Winterfeldt, D., Sokolowski, J., & Collins, A. J. (2010). Probabilistic Risk Analysis and Terrorism Risk. *Risk Analysis*, *30*(4), 575–589. https://doi.org/10.1111/j.1539-6924.2010.01401.x

Ghouri, M. F. (2020). GSM And IoT Based Smart Traffic System With Geofencing. *Journal of Independent Studies and Research Computing*. https://doi.org/10.31645/16

Joewono, T. B., & Kubota, H. (2006). Safety and security improvement in public transportation based on public perception in developing countries. *IATSS Research*, *30*(1), 86–100. https://doi.org/10.1016/s0386-1112(14)60159-x

Kiełek, K. (2022). The importance of safety and security in urban space. *Humanities & Social Sciences Reviews*, *10*(6), 21–23. https://doi.org/10.18510/hssr.2022.1063

Nayak, B., Mugali, P. S., B. Raksha Rao, Saloni Sindhava, Deivis Disha, & K. Swarnalatha. (2019). GeoFencing-Based Accident Avoidance Notification for Road Safety. *Advances* *in Intelligent Systems and Computing*. https://doi.org/10.1007/978-981-13-6001-5_30

Oviedo-Trespalacios, O., Haque, M. M., King, M., & Washington, S. (2016). Understanding the impacts of mobile phone distraction on driving performance: A systematic review. *Transportation Research Part C: Emerging Technologies*, *72*, 360–380. https://doi.org/10.1016/j.trc.2016.10.006

Safarpour, H., Khorasani-Zavareh, D., & Mohammadi, R. (2020). The common road safety approaches: A scoping review and thematic analysis. *Chinese Journal of Traumatology*, *23*(2), 113–121. https://doi.org/10.1016/j.cjtee.2020.02.005

Shaygan, M., Meese, C., Li, W., Zhao, X. (George), & Nejad, M. (2022). Traffic prediction using artificial intelligence: Review of recent advances and emerging opportunities. *Transportation Research Part C: Emerging Technologies*, *145*, 103921. https://doi.org/10.1016/j.trc.2022.103921

Weibull, K., Kunclová, T., Lidestam, B., & Prytz, E. (2024). Geofencing to prevent collisions in drivers' interactions with emergency vehicles. *Transportation Research Interdisciplinary Perspectives*, *28*, 101297. https://doi.org/10.1016/j.trip.2024.101297

World Health Organization. (2018). *Global status report on road safety 2018*. https://www.who.int/publications/i/item/9789241565684

Zhao, X., Carling, K., & Håkansson, J. (2017). *An Evaluation of the Reliability of GPS-Based Transportation Data*. Retrieved January 18, 2026, from https://www.diva-portal.org/smash/get/diva2:1177896/FULLTEXT01.pdf

AUTHOR'S BIOGRAPHY

Louther Jan C. Adarle received his Bachelor's Degree in Information Technology at the University of Negros-Occidental-Recoletos with a passion and interest in Multimedia and a College Instructor at STI-West Negros University.

Kenneth Brian G. Mallo received his Bachelor's Degree in Information Technology at the University of Negros-Occidental-Recoletos with a focus on Web Development and Multimedia.

Johnedel S. Mapa received his Bachelor's Degree in Information Technology at the University of Negros-Occidental-Recoletos, and a Fitness Enthusiast, a Tech Savy, and Software Developer.