

Mobile-Based Smart Transport Route Optimization and Hazard Reporting System for San Juan

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Abstract: The aim of this study is to develop a Mobile-Based Smart Transport Route Optimization and Hazard Reporting System that could improve navigation, minimize travel time, and increase road safety in San Juan City. The complex road system of the city and the ever-changing traffic rules, such as one-way and two-way rules based on time, pose great challenges to drivers, which often result in congestion and unintended traffic violations. This study solves these problems by giving a localized and adaptive navigation solution. The proposed system uses a combination of Dijkstra's Algorithm, Google Maps Application Programming Interface and real-time traffic information to produce the most efficient and accurate routes. It also has a hazard reporting feature that allows users to share updates on accidents, road closures, police presence, and other disruptions. Other features include English and Tagalog voice navigation, a built-in speedometer with overspeed warnings, two-factor authentication for secure access, a favorites feature for easy recall of commonly traveled routes. The system was developed following an iterative prototyping approach with user feedback and validated and filtered with data collected from local drivers and the San Juan City Traffic and Parking Management Office to maintain accuracy and usability. Its area of focus is private vehicles, motorcycles, and taxis that are operating within San Juan City. Findings indicate that the system offers better route guidance, minimizes traveling time, and improves the safety of commuters by combining algorithmic route optimization and community-based hazard reporting. This study illustrates the role of localized systems in ensuring safer and efficient mobility in urban settings. This study shows the need to design navigation tools based on the actual community needs and conditions. Through the case of San Juan City, the system demonstrates how technology can directly address daily traffic issues, can offer a safer traveling experience, and can also serve as an example that can be copied in other cities with complicated traffic schemes.

Keywords: Smart Transport System, Route Optimization, Hazard Reporting, Dijkstra's Algorithm, Mobile Application, Urban Mobility, San Juan City

I. Introduction

Artificial intelligence enables machines to perform tasks that usually require human intelligence, such as making decisions and problem solving. Machine learning enables systems to improve over time by learning from data without requiring step-by-step programming. Artificial intelligence is integrated into this project using Dijkstra's Algorithm, a pathfinding algorithm that finds out the shortest and most efficient route between two points. Considering road networks and travel distances, the system ensures optimal navigation for users in San Juan's congested urban environment.

This study aims at developing a navigation system with user-based hazard reporting to enhance road safety and travel efficiency. The users will have turn-by-turn voice guidance, thereby guaranteeing hand-free navigation. A significant feature of the system is the hazard reporting capability, where drivers can report police presence, road accidents, or other disruptions, thereby enabling others to make sound route choices. The system will also have an integrated speedometer with the objective of monitoring a driver's speed, as well as speed alerts that notify users when they exceed established speed limits.

The proposed system has major benefits to daily drivers in reducing travel uncertainty, providing safer and more efficient travel, and providing greater route awareness through user-initiated hazard reporting. With the combination of Dijkstra's Algorithm for optimal routing and current route conditions based on reported data, voice directions, speed tracking, and alternate route providing, the system will seek to improve commuter experience and improve road safety across San Juan. The system will provide support for both English and

Tagalog, thus further making the system accessible to more people.

II. Objective of The Study

The Objectives of the Study state the general purpose of the study and the steps that need to be taken for its fulfillment. In this section, the steps on how the system proposed here will solve the problems identified and enhance navigation efficiency for drivers in San Juan City.

General Objectives

The main objective of this study is to design a Mobile-Based Smart Transport Route Optimization and Hazard Reporting System for San Juan that supplies drivers with traffic-optimized routes according to current traffic rules. The system has the purpose of

improving navigation, decreasing travel time, and ensuring road compliance through the provision of real-time, locally optimized traffic information. Unlike other navigation programs, this system will concentrate solely on San Juan City, providing more accurate and consistent route suggestions specifically to the city's distinct traffic flow.

Specific Objectives

1. To develop a mobile-based system that provides optimized routes for drivers: The system will generate the best routes considering the current traffic regulations and user-reported hazards to navigate accurately and with reliability
2. To identify the traffic challenges faced by drivers in San Juan City: This study will examine the main reasons for traffic congestion, especially on crowded streets, and determine the effect of these issues on travel efficiency and wayfinding.
3. To integrate updated traffic schemes into the system: The system will always update one-way and two-way street regulations, road closures, and other traffic alterations to help drivers in evading confusion and making correct decisions on routes

III. Review of Related Literature

A. Digital Navigation and Its Impact on Travel Behavior

Digital navigation, which combines satellite positioning, digital mapping, and route guidance, has a substantial impact on travel behavior and use of the road network. Digital navigation, according to Metz, D. (2022), has produced significant changes in road network behavior, such as rerouting local trips to take advantage of capacity available on strategic roads and a rise in minor road usage. Although these changes present challenges for road network administration and investment in infrastructure, digital advantages, notably in reducing uncertainty in journey times. The capacity to forecast estimated time of arrival based on anticipated traffic conditions allows for more efficient travel through congested areas. Nonetheless, there is still a scarcity of extensive research on the general influence of digital navigation on travel behavior, calling for more studies to maximize road network performance.

B. Artificial Intelligence in Enhancing Transport Systems

Artificial Intelligence is increasingly known for its contribution to enhancing the efficiency and dependability of contemporary transport systems. Malik et al. (2023) states that AI technologies like machine learning, deep learning, and natural language processing have greatly improved many industries, including transport. AI driven transport systems solve major issues like unreliable public transport timetables, dangerous driving habits, and operational inefficiencies. By incorporating AI based solutions, transportation systems can be made more reliable, secure, and sustainable. Moreover, AI helps in preventing cyberattacks, traffic management optimization, and improved delivery of public services. AI in intelligent transport systems is vital in making the future of mobility more efficient and secure. Wayfinding and navigation research for sustainable transport.

C. Challenges in Learning Dijkstra's Algorithm

Dijkstra's algorithm can be tricky for students to understand because of typical misconceptions and confusion about its basic concepts. As stated by Tilanterä (2024), students usually mix up crucial components like spanning trees, fringes, and priority queues, which make them fail to use the algorithm correctly. They can also fail to see the greedy and dynamic programming principles that constitute Dijkstra's shortest-path technique. Interviews and observations indicate that visualization aids used in the teaching process may also be a factor in such misinterpretations. These observations identify the need for well-designed instruction strategies and easy use learning tools to ensure that students grasp and apply graph algorithms correctly.

D. Impact of Dynamic Routing on transportation system

People rely on Navigation Systems to identify the best path from one point to another. This kind of system has two types, which is a static and dynamic that identifies the pathway in the system being the static returns the fastest route while dynamic adapts its pathway with the data inputs. A literature written by Bagabaldo et al. (2024) seeks to evaluate the impact of dynamic navigation applications in transportation networks with the use of susceptible infected recovered (SIR) model to understand the congestion dynamics reveals the improvement of traffic system performance when 30% of the users adopt dynamic routing. This study is an important insight to identify the connection between navigation apps and traffic congestion.

E. Transport Navigation System Usability Factors

Waze application provides service for people to navigate an area through pathway guidance and route recommendation. According to Gumasing et al., (2023) conducted a study about antecedents of Waze mobile application usage as a solution for sustainable traffic management among Gen Z reveals that system quality, location accuracy, usefulness, and ease of use affect Gen Z's intentions to utilize traffic navigation applications.

F. Implementation of Dijkstra's Algorithm in a City

Dijkstra's Algorithm is effective in identifying the shortest path between points in a graph by applying a greedy strategy to select the minimum cost at each step. Sari et al. (2021) implemented the algorithm to calculate the optimal route from City A to City G, achieving a result of 6 km through the path A–C–D–E–G. This study highlights the practical application of Dijkstra's Algorithm

in real-world route optimization, making it relevant to the present research on transport route efficiency. The use of Dijkstra's Algorithm in this study demonstrates its effectiveness in achieving route optimization. Its proven ability to compute efficient and adaptive paths under real-world conditions supports its application in determining accurate and time-saving routes within San Juan City's transport network.

Title	Accuracy
Google Maps	92%
Waze	92%
Apple Maps	85%
TomTom Maps	80%
Sygy Maps	82%

Table 2.1: Comparison of Accuracy to Similar Studies

Conceptual Framework

The conceptual framework sets out the relations between system entities that enable enhanced, real-time, and user-centric navigation responsive to evolving traffic in San Juan City. User input, artificial intelligence, and traffic data enable the system to give effective and accurate route advice.



Figure 2.2: Input-Process-Output Model

Figure 2.2 sets out the relations between system entities that enable enhanced, real-time, and user-centric navigation responsive to evolving traffic in San Juan City. User input, artificial intelligence, and traffic data enable the system to give effective and accurate route advice.

Input Phase users start with typing in their trip description including the place of origin, the destination and the desired travel options. The system also gathers real time traffic data such as congestion, temporary road closures, two way and one way streets reversal and community party hazard. It also considers road laws like time restrictions and speed limits, which make routes in line with existing road policies.

Process Phase. The system collects data based on Google Maps API and the database that is from the Traffic and Parking Management Office. It finds the most efficient and shortest path with the help of Dijkstra Algorithm and lives up to the current traffic circumstances. Reports that are received through users that indicate hazards like accidents, roadblocks or police stops are recalculated back into the route to ensure that the route remains accurate and safe. The speed monitoring too is carried out wherein the system measures the speed of the vehicles and provides alerts when the limits are crossed. The system is further usable in wider language, English and Tagalog to improve the usability.

Google Maps API offers the current streaming information on the traffic flow, traffic congestion, and temporary road accidents, whereas the Traffic and Parking Management Office database offers official traffic rules, like fixed one-way designations and road reversals which happen on a time basis. To combine these databases, the system uses a validation mechanism based on the time in which the latest data is used as a priority.

In case of discrepancies, the information about road closures provided by Google Maps does not match that of the Traffic and Parking Management Office records, the rule-based conflict resolution module is used, with Traffic and Parking Management Office data being prioritized as it is official information, which is confirmed. In the meantime, hazards that are reported by users are added to the dataset awaiting community verification. To ensure integrity of data, a filtering system is used to eliminate redundant or outdated data.

Algorithm Design and Adaptation. This system uses an adapted form of Dijkstra Algorithm which adjusts dynamically to the real-time conditions including hazard reports, traffic jams and time-based one-way road plans. The road sections are modeled as an edge in a weighted graph, the weights of the edges are calculated based on the distance, the time of travel and the traffic congestion. New data is received in the form of a hazard report by a user, a shift in direction for traffic by the TPMO, or a congestion report by the Google Maps API, the concerned segments are automatically reweighted or temporarily limited. These updates are considered triggers causing the algorithm to re-calculate the shortest route between the current location of the user and the destination. This dynamic recalculation will make sure that the system gives a constantly optimal and safe route, which is updated in the current road conditions. The classic fixed Dijkstra method is adapted in a way that it becomes a responsive and intelligent routing system that can handle the mobility of urban cities through this event-driven adaptation.

Output Phase. The system provides optimized path directions having turn by turn audible feedback, which consider unexpected traffic alteration or reported dangers. Speed alerts can inform drivers whether they are over speeding or not and warn them about the possible dangers on the road. Hazard reporting through the community will be beneficial to everybody, making it more responsive to navigation. New directions are provided with the latest traffic modifications including reversal of directions or time-driven plans, and the dual language, mobile-friendly interface makes the experience accessible and easy to use.

The system design is based on the client server architecture in which the mobile application is the client which communicates with a central web server. The client receives the user input in its form including the origin, destination, and hazard reports and retrieves the current GPS position of the device, as well. The API calls are sent to the server. The server acts as the processing center, combining these user inputs with live traffic information through Google Maps API and formal road scheme information through the San Juan Traffic and Parking Management Office. The server has a data fusion module that filters, prioritizes and synchronizes these multiple inputs with the goal of ensuring that they are accurate and then routes them to a modified Dijkstra-based route optimization engine within the system. When processing is finished, the refined route, hazard alerts as well as voice guidance instructions are relayed back to the mobile client where it is displayed and navigated in real-time. This client-server model can also support constant communication, which means that all navigation sessions will be based on the most current traffic conditions and confirmed hazard data.

IV. Methodology

This chapter presents the methodology used in developing the San Juan mobile based smart transport route optimization and hazard reporting system. This gives a systematic and logical way of assuring the reliability, efficiency and effectiveness of the system. Research methodology is important because it dictates how data is collected, how the system is designed, implemented and tested to ensure that the study is done in a logical and structured manner.

A. Research Design

This study follows the Agile cycle, an iterative and flexible development process that focuses on collective feedback and evolution of the process through the development cycle. Agile breaks the project into small manageable increments, so that the system is developed efficiently and constantly improved based on user feedback. Thus, the model helps to facilitate collaboration between developers, stakeholders, and end users to enable the final product to be defined as expected by the end users.

The study uses Prototyping Model within Agile development approach whereby early user involvement and iterative refinements can be provided. The Prototyping Model allows us to create an initial working prototype which goes through several iterations based on feedback until the system satisfies all functional requirements. The process of development is broken down into the following phases.

Requirements

At its most basic, a requirement is a service, function or feature that the user requires. Requirements can be functions, constraints, business rules or other aspects that are necessary to satisfy the needs of the target users. Stakeholders are asked for initial requirements to know their needs and challenges. This phase is flexible, and changes are allowed throughout the development process.



Figure 1: Prototype Model

Prototype Development

is the process of building an early version of a product or system to investigate how it functions, appears, and behaves before full development is committed. Through this reduced-scale testing, developers can find design defects or technical problems and adjust ahead of time. Gathered requirements are used to develop a basic prototype. This prototype is the first version of the system with essential functionalities, which enables the users to interact with and evaluate its features.

The prototype will be used as a starting point in obtaining feedback from users and stakeholders to make sure that the system satisfies the needs and expectations of users and stakeholders. This phase is important to develop the user interface, functionality, and general user experience on realistic interactions and not assumptions.

User Evaluation

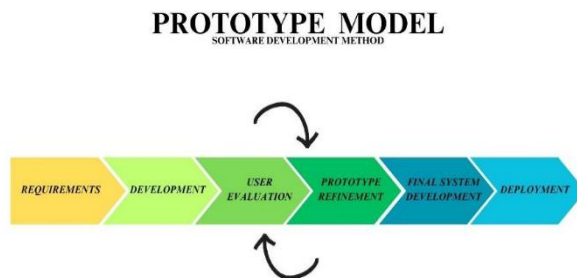


Figure 2: User Testing



Figure 3: User Testing

User evaluation is a systematic process that analyzes the way users engage with a digital product to evaluate its usability, accessibility, and satisfaction. Through methods such as usability testing, interviews, and data analysis, it detects problems and areas for improvement to make each interaction valuable and lead to a smooth user journey. The prototype is evaluated by users to determine if it is viable and usable. The feedback is gathered to determine things that can be improved on and more feature requirements.

Prototype Refining



Figure 4: Data Collection

The system gathers user registration information such as name, contact details, and location to initialize the user profile.

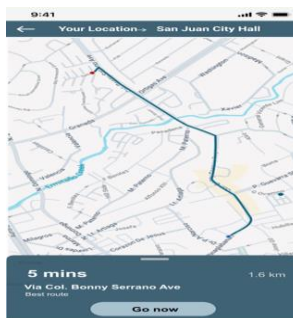


Figure 5: Route Optimization

The system determines the most efficient route based on distance, traffic conditions, and estimated travel time.

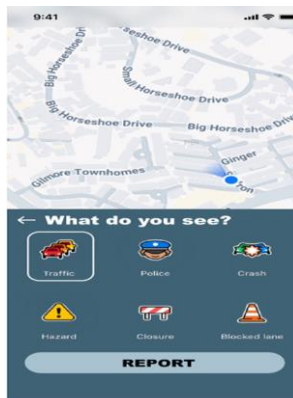


Figure 6: Hazard Processing

Users can report road hazards, traffic congestion, or blockages, which are shared to alert other drivers in real time.



Figure 7: Speed Monitoring

The system tracks vehicle speed and displays navigation guidance to ensure safe and efficient driving.

Prototype refining is the important phase of enhancing the original model by correcting problems, optimizing performance, and making it ready for release. This is done to ensure the final product is of high quality and efficiently serves the purpose of the users. User feedback is used to modify them. It is tested again, and the enhancements and issue resolutions are applied. It continues until the system meets the user's expectations

Final System Development

Final system development is the step in which the finished and working system is built based on the enhanced prototype. After feedback has been implemented and changes done, developers build the full version with all the functions required, test it extensively, and get it ready for deployment in the real environment. This is when the prototype is refined and accepted, and the final system development is started with all necessary features to produce a robust and functional application.

Deployment

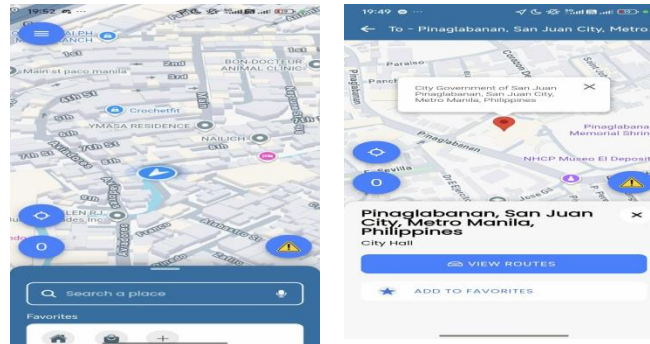


Figure 8: Juan Map Application

Deployment is the releasing of a computer program for usage through work such as getting it ready, installing, and setting it up on target machines. The aim is to relocate the software from development to production while guaranteeing that it runs well and fulfills the user's expectations. The system is deployed for use. The configurations and optimizations are made to operate smoothly in a real world environment.

Maintenance

The Maintenance phase of the is essential to ensure continuous software functionality, carry out required repairs and updates, and maintain the software as relevant and functional in the long term. There is continuous maintenance, bug fixes, performance optimizations, feature updates according to user evolving needs.

Data Collection Techniques

There are two primary techniques used for gathering the required data to develop the San Juan Mobile-Based Smart Transport Route Optimization and Hazard Reporting System. To determine the common traffic problems, routing behavior, and the usability of available route-planning applications, first, interviews with daily drivers and San Juan City Traffic and Parking Management Office officials were carried out to identify common traffic issues, routing behavior, and the usability of existing route-planning applications. Second, questionnaires and feedback forms were administered to the prospective users in San Juan to find out how well the system performs, how it can be used easily and how useful it is in solving transport issues. These data collection techniques that included the use of questionnaires, structured interviews and on-site consultations made sure that the system was built around the real-time traffic conditions and the real needs of the users.

The system has a formal data integration procedure among the Google Maps API feeds, user-generated reports and Traffic and Parking Management Office datasets to guarantee reliability and synchronization of the data. Any data e.g. an incident report, congestion update, or traffic regulation is time-stamped and verified by a consistency check and then merged with the central database. The integration framework will also ensure that official Traffic and Parking Management Office updates are prioritized in case of a discrepancy and Google Maps API has real-time responsiveness. The user generated hazard reports are tentatively authenticated and sorted in accordance with frequency and user-reputation scores, in such a manner that only correct reports dictate the optimization of the route production.

Sampling Methods

The stakeholders were the officials of San Juan City Traffic and Parking Management Office, and the respondents were everyday drivers and commuters in the city. This is because they are directly involved in traffic management, and they have the experience of traversing the road networks in San Juan. Purposive sampling was utilized because the participants had to comply with certain

criteria that were applicable to the assessment of the Mobile-Based Smart Transport Route Optimization and Hazard Reporting System.

Data Analysis Procedures

Nearly all the data presented by the respondents of the survey and the feedback contributors were collected and analyzed through means, percentages, and other descriptive statistics. These findings showed what needs to be changed in the system and what features may be introduced to make the system more user-satisfying. Results also revealed that the system needs to be expanded further to enhance usability and general performance.

Validity and Reliability Measures

To guarantee the validity of the study, the system was tested repeatedly by real users. The survey tools were well designed and tested to be understandable, viable and relevant in collecting useful feedback. By examining the answers against the proposed functions and objectives of the system, the content validity was enhanced because it showed that the instrument was able to measure what it was intended to measure. The consistency of the system was determined by repetitive experiments where the system gave the same result at various times of testing. This ensured the stability, reliability and reproducibility of the system and strengthened the validity of the study findings.

Ethical Considerations

When creating and implementing the Mobile-Based Smart Transport Route Optimization and Hazard Reporting System in San Juan, ethical considerations were adhered to guarantee data privacy, user security, and appropriate use of the systems. The research was also in compliance with the Data Privacy Act of 2012 (RA 10173) to ensure the safety of sensitive user data, and personal data like addresses saved and route history were encrypted safely. There is Multi-Factor Authentication (MFA) and robust account protection to avoid unauthorized access. The privacy policy was used to give informed consent by stating how the data were going to be collected, stored and how they were going to be used. Traffic and hazard reports posted by the users were handled in a manner that ensured anonymity and elimination of personal information. Moreover, the system did not give biased route suggestions to offer reliable and fair navigation.

V. Results and Discussion

Results

A total of 300 respondents participated in the survey to evaluate the Mobile-Based Smart Transport Route Optimization and Hazard Reporting System for San Juan. The assessment was based on eight quality criteria: Functional Suitability, Performance Efficiency, Compatibility, Usability, Reliability, Security, Maintainability, and Portability. Responses were measured using a 5-point rating scale (1 = Poor to 5 = Excellent) in accordance with ISO/IEC 25010 standards. The results were summarized through mean scores and visual graphs to provide a clearer understanding. This section presents the findings and explains how they correspond with the objectives of the study.

A. Functionality

The average mean score of the system on Functional Suitability was 4.72 (Excellent). Most of the respondents firmly believed that the application offers everything they need, including the optimization of the routes within San Juan City, the correct identification of the most efficient route depending on the current traffic, the voice guidance, and the ease of reporting road hazards.

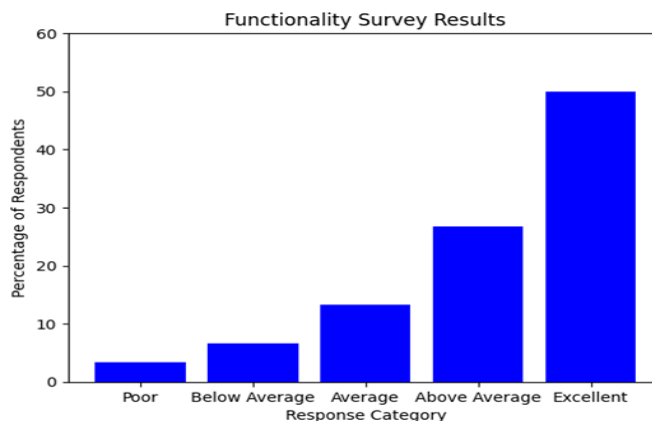


Figure 5.1: Bar Graph for Functionality

This indicates that the system addresses the functional requirements of users effectively, particularly regarding core navigation features. Respondents confirmed that features like accurate route navigation, hazard reporting, and speed alerts are useful in optimizing routes in San Juan City, ensuring the app provides the necessary tools for reliable navigation.

B. Performance

The system achieved a General Weighted Mean of 4.46 (Above Average) for Performance Efficiency. Respondents noted that the application's interface responds immediately to user input, processes route optimization and hazard reporting results quickly, and maintains performance without causing lag or crashes.

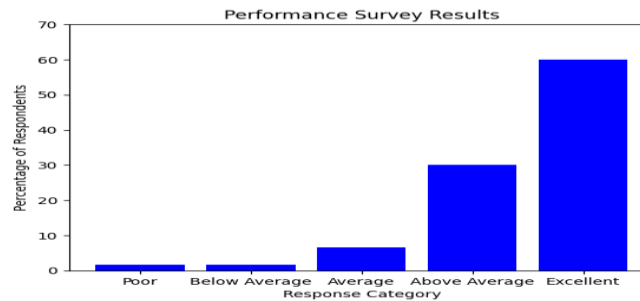


Figure 5.2: Bar Graph for Performance

The results show that the system can handle simultaneous tasks effectively. This performance evaluation further validates that the application's real-time functionalities, such as turn-by-turn guidance and receiving hazard updates, can run efficiently within a mobile-based environment. This contributes to a faster and more reliable navigation experience for users in San Juan City.

C. Compatibility

The system earned a General Weighted Mean of 4.10 (Above Average) for Compatibility. Users confirmed that the application performs well across different operating systems (Android or iOS) and successfully connects to and uses the device's GPS and cellular data without conflict. Furthermore, hazard reports submitted by one user are correctly and immediately visible to other users on their map display, and the app integrates well with the Google Maps API for real-time traffic data.

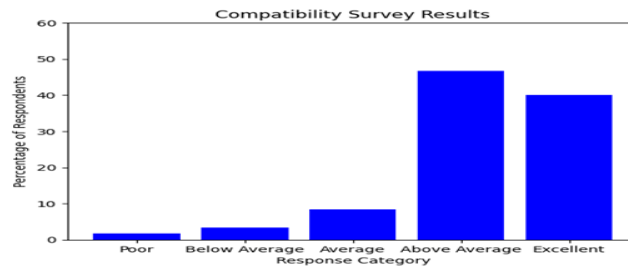


Figure 5.3: Bar Graph for Compatibility

This shows that the system can function across devices with different features and successfully communicate critical real-time data between users and with external services, making it practical for large-scale deployment.

D. Usability

The system obtained a General Weighted Mean of 4.74 (Excellent) for Usability. Most respondents strongly agreed that the application is user-friendly, providing clear navigation, an intuitive layout. Questions scored highly, confirming that it is clear what the app is designed to do, and it is easy to navigate through the app's menus and features.

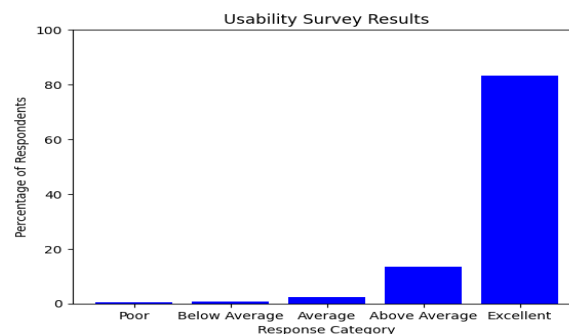


Figure 5.4: Bar Graph for Usability

The results indicate that minimal training is required, and the system design allows users to focus on tasks without difficulty. The high scores also confirm that error messages, when they appear, are clear and help the user resolve the problem, contributing to a seamless and efficient user experience.

E. Reliability

The system received a General Weighted Mean of 4.64 (Excellent) for Reliability. Respondents noted that the application operates continuously without unexpected crashes, consistently maintains an accurate GPS connection, and ensures hazard reports are successfully received and processed by the system without failure.

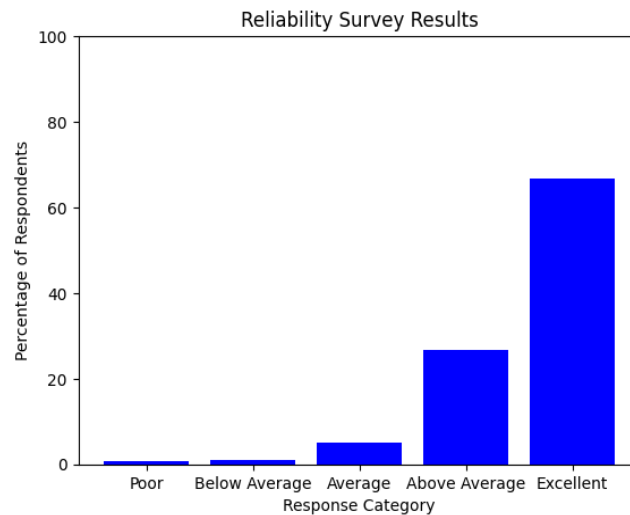


Figure 5.5: Bar Graph for Reliability

This demonstrates that users can trust the system to maintain stable operations and preserve the integrity of their data, as the application successfully recovers data after an interruption. The high reliability score ensures continuity of navigation workflow.

F. Security

The system achieved a General Weighted Mean of 4.76 (Excellent) for Security. Respondents expressed strong confidence that the system protects sensitive user location and reported hazard data. This confidence is driven by clear communication on data usage and protection, and the secure functioning of the Multi-Factor Authentication process.

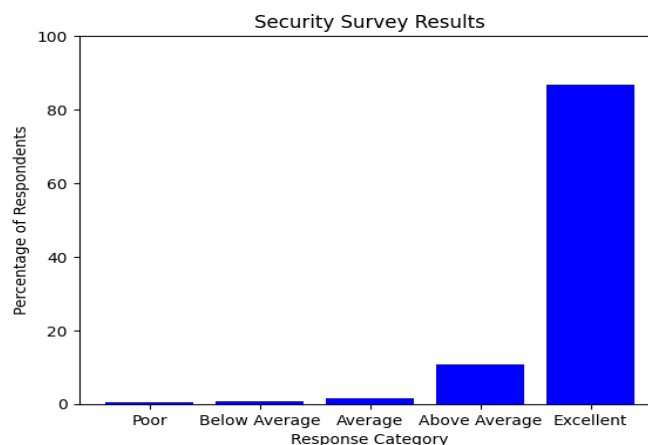


Figure 5.6: Bar Graph for Security

This suggests that user data is safeguarded against unauthorized access and modifications, aligning with the system's objective of ensuring secure data handling through features like secure password changes and requiring appropriate permissions when accessing device features.

G. Maintainability

The system scored a General Weighted Mean of 4.02 (Above Average) for Maintainability. Users believe that the design and structure of the system make it possible to update, fix bugs, and enhance features without significant difficulty.

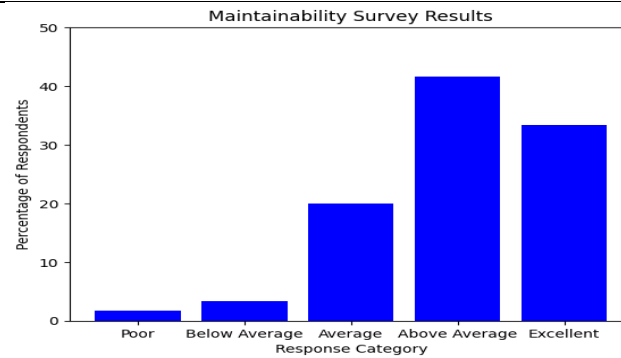


Figure 5.7: Bar Graph for Maintainability

This indicates that the system can be maintained efficiently over time, supporting future improvements or upgrades. Furthermore, users noted that the app receives regular updates that improve functionality, ensuring its long-term viability.

H. Portability

The system received a General Weighted Mean of 4.58 (Excellent) for Portability. Respondents agreed that the application installs easily, adapts properly to different screen sizes, and functions correctly and consistently across different models of mobile devices without compatibility issues.

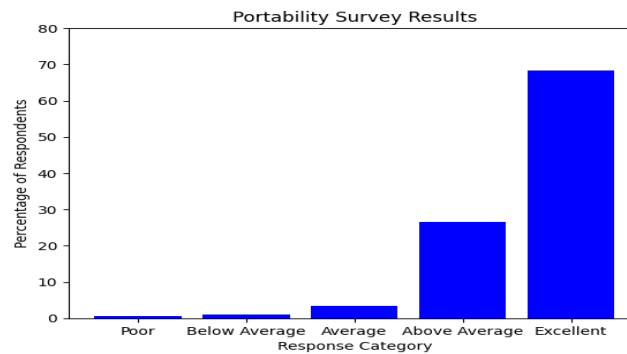


Figure 5.8: Bar Graph for Portability

This demonstrates that the system is accessible and convenient for users across a variety of devices, which is essential for widespread adoption. The high scores also indicate that it is easy to move data or settings to another device, ensuring a smooth user transition between devices.

Evaluation Metrics

CRITERIA	GENERAL WEIGHTED MEAN	VERBAL INTERPRETATION
Functional Usability	4.72	Excellent
The app offers all the functions required for optimizing routes in San Juan City.	4.75	Excellent
The app accurately identifies the most efficient route based on current traffic conditions.	4.60	Excellent
The app's turn-by-turn voice guidance is helpful and relevant during navigation.	4.80	Excellent
The process for reporting road hazards is simple and quick to execute.	4.50	Excellent
The app's speedometer and speed alerts accurately reflect my vehicle's speed and local speed limits.	4.90	Excellent
Performance Efficiency	4.46	Above Average
The app processes route optimization and hazard reporting results quickly.	4.50	Excellent
The app does not cause my device to significantly slow down or overheat during a 30-minute navigation session.	4.60	Excellent
The app remains fast and responsive even while providing turn-by-turn guidance and receiving hazard updates simultaneously.	4.45	Above Average
The app's interface responds immediately to user input.	4.30	Above Average
The app maintains performance without causing my device to lag or crash.	4.45	Above Average
Compatibility	4.90	Above Average
Hazard reports submitted by one user are correctly and immediately visible to other users on their map display.	4.25	Above Average
The app successfully displays the map and location data.	4.50	Excellent
The app successfully connects to and uses the device's GPS and cellular data without conflict.	4.80	Above Average
The app integrates well with the Google Maps API for real-time traffic data.	3.90	Above Average
The app performs well across different devices or operating systems I tested (Android or iOS).	3.75	Above Average
Usability	4.74	Excellent
It is clear what the app is designed to do when I first open it.	4.85	Excellent
Users should be able to learn how to use the route optimization and hazard reporting features quickly based on the design.	4.70	Excellent
Navigation through the app is simple and intuitive.	4.85	Excellent
The app warns me when I perform an action incorrectly (e.g., submitting a report with a bad connection).	4.80	Excellent
The app's colors, fonts, and layout make it pleasant to use.	4.70	Excellent
Reliability	4.64	Excellent
The system did not crash, freeze, or unexpectedly close during the testing session.	4.90	Excellent
The app is available and responsive whenever I want to use it.	4.85	Excellent
The app recovers smoothly after an error or failed search.	4.70	Excellent
The app saves my route history and settings, so I don't lose important data.	4.55	Excellent
If the app is closed and reopened, the system successfully restores the previously active route or destination.	4.80	Excellent
Security	4.76	Excellent
The system clearly communicates how user location and reported hazard data are used and protected.	4.90	Excellent
The Multi-Factor Authentication process for logging in is secure and functions correctly.	4.85	Excellent
The app maintains logs of my activities securely if needed.	4.70	Excellent
The account management screen allows the user to securely change their password and contact information.	4.95	Excellent
The app requires appropriate permissions and authentication when accessing device features.	4.80	Excellent
Maintainability	4.82	Above Average
The app receives regular updates that improve functionality.	4.20	Above Average
The core functions (routing, reporting) appear to run as separate, stable units without interfering with each other.	4.05	Above Average
When an error occurs, the system provides clear, descriptive error messages (e.g., "GPS not found") that help diagnose the issue.	3.85	Above Average
The app is flexible and evolves to include requested features.	4.00	Above Average
The system's logging or reporting features make it easy for developers to verify the quality and accuracy of the route results.	4.00	Above Average
Portability	4.58	Excellent
The app functions correctly on different mobile devices I have used.	4.75	Excellent
The system functions correctly and consistently across different models of mobile devices being used for testing.	4.60	Excellent
It's easy to move my data or settings to another device with this app.	4.40	Above Average
The app's interface adapts properly to different screen sizes (phone and tablet).	4.50	Excellent
Installing the app on the testing device was a simple and quick process.	4.65	Excellent

Figure 5.9 Overall Summary Survey

Overall, the San Juan City Route Optimization System received positive evaluations across all eight quality criteria. Usability, with a General Weighted Mean of 4.74, and Security earned the highest ratings, showing that users found the system intuitive, easy to navigate, and were confident in its ability to safeguard sensitive data. Functional Suitability and Reliability also scored highly, reflecting that the system is equipped with the essential core routing functions and maintains stable operations without crashing.

Meanwhile, Portability and Performance Efficiency received favorable but slightly lower ratings compared to the top categories, suggesting that while the system is generally fast and adaptable to different devices, further optimization could improve responsiveness under heavy load and long-term sustainability across future operating system updates. Compatibility and Maintainability received the lowest ratings, highlighting opportunities for enhancement in adaptability across more environments and ease of future updates/bug fixes.

Overall, the survey results confirm that the system meets user expectations by providing an accessible, functional, and secure platform for navigation within San Juan City, while also highlighting opportunities for enhancement in terms of performance optimization and maintainability for future development.

Discussion

The survey results reveal how the San Juan City Route Optimization System can significantly improve the commute and travel experience of users by streamlining navigation and hazard reporting processes. The initial findings show that the system's strength lies primarily in its Usability and Functional Suitability. These high ratings indicate that the system's core features such as accurate route identification, version history, and hazard reporting are effective and user-friendly. The favorable responses confirm that the interface is user-friendly, allowing drivers to quickly adapt to the system without requiring extensive training.

Performance was also evaluated positively, with Performance Efficiency and Compatibility receiving solid scores. This demonstrates that the system is capable of handling multiple tasks smoothly, such as processing real-time traffic data and rendering map views, and is adaptable to different devices and environments. This ensures that users can reliably access and use the navigation features across platforms with minimal issues.

Security and Reliability were highlighted by the respondents as essential aspects, with both achieving Excellent ratings. Users expressed high confidence in the system's ability to safeguard their location data and maintain stable performance throughout long trips. The system's reliable performance ensures continuity of the navigation workflow, though the strong focus on security suggests that users highly value the system's commitment to protecting their privacy.

Finally, Maintainability and Portability were rated favorably but indicate areas for improvement. While the system can be deployed easily across devices, the slightly lower ratings suggest that long-term sustainability and the ease of future updates need to be continuously monitored to keep up with evolving technology. Overall, the positive feedback confirms that the proposed system is a practical, reliable, and highly beneficial solution that meets its objectives of enhancing route optimization, accessibility, and safety in San Juan City.

Even though the system scored highly in most of the criteria, the slight difference in the ratings of Maintainability and Compatibility implies the opportunities to improve the system in the long term. Such outcomes can be explained by differences in hardware of the devices, operating systems and different periodicity of updates of third-party applications like Google Maps. As part of enhancing sustainability in the long term, the modular code design, automated code update checks, and version control methods should be used in future development, to enable the system to be easily updated to new android and iOS releases. Moreover, when the application is expanded out of the boundaries of San Juan City, cloud-based database management and load balancing capabilities would be taken into consideration to support more users, more simultaneous requests as well as increased amounts of real time traffic data. The consideration of these points will make the system more robust and capable of scaling to bigger urban applications.

VI. Conclusion and Recommendations

Conclusion

In summary, the development of the Mobile-based Smart Transport Route Optimization and Hazard Reporting System for San Juan using Dijkstra's Algorithm and Real-Time Data Processing demonstrates how intelligent, location-based applications can significantly improve urban navigation. The system successfully addresses key commuter challenges such as the difficulty in finding the most efficient route and the lack of real-time hazard awareness. By implementing accurate route identification, instantaneous crowd-sourced hazard reporting, and reliable turn-by-turn guidance, the system provides users with a modernized approach to travel that ensures better efficiency, improved safety, and more reliable trip planning.

The adoption of an agile methodology throughout the development process ensured a user-centered design, iterative refinement, and flexibility, resulting in a highly functional and responsive system prototype. Results from the user evaluation survey indicated that the system performed exceptionally well across all eight quality attributes based on the ISO 25010 standard. The system achieved its highest ratings in Security (4.76) and Usability (4.74), followed closely by Functional Suitability (4.72) and Reliability (4.64). These scores confirm that the system is highly reliable, user-friendly, and secure.

Ultimately, this study highlights the significance of integrating real-time mobile technologies into urban navigation to create an intelligent environment that reduces travel stress and enhances collaboration through crowd-sourced reporting. The system's success, confirmed by an Overall General Weighted Mean of 4.50 (Excellent), demonstrates that it meets its core objectives of enhancing route optimization, accessibility, and safety in San Juan City.

Recommendations

Based on the findings of this study, the proponents recommend the following for future improvements and expansion of the system:

1. **Integration of Predictive Traffic Modeling:** Future versions of the system should incorporate machine learning models to predict traffic conditions not only based on current real-time data but also on historical patterns (time of day, day of the week, weather). This would improve the accuracy of ETAs and allow for proactive route adjustments.
2. **Real-Time Collaborative Route Planning:** Adding features that allow multiple users (e.g., a family, a convoy) to share destinations and view each other's current routes would enhance coordination and efficiency for group travel.
3. **Third-Party API Integration (Ridesharing/Public Transit):** Expanding compatibility with external services, such as local ride-sharing platforms (Grab, Angkas) or public transport schedules, would allow users to compare the optimized driving route with other mobility options directly within the app.
4. **Expansion to Metropolitan Area Use:** The system can be scaled beyond San Juan City to serve the entire Metro Manila area, offering standardized route optimization and hazard reporting practices across multiple congested cities.
5. **Mobile Offline Access (Map Caching):** Introducing offline storage and synchronization features would enable users to download map tiles and access basic routing functions even without cellular connectivity, with updates applied once connected online.
6. **Deployment to Official App Stores:** Publishing the mobile application officially to the Google Play Store and Apple App Store will significantly increase accessibility for users.

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