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TC-Trissea (Tuguegarao City Tricycle Riders Information, Security and Satisfaction Enhancement App): A Proposed Mobile App for Tricycle Commuters of Tuguegarao City

Jesus B. Pizarro, Maria Visitacion N. Gumabay, Sheena G. Gumarang

Abstract: ***The tricycle transportation system in Tuguegarao City in Northern Philippines is perennially confronted with problems and challenges that have to do with the tricycle commuters' safety, the quality of service that they receive from drivers and their deteriorating overall level of satisfaction as commuters. To address these issues, the Tuguegarao City Tricycle Riders Information, Security, and Satisfaction Enhancement App (TC-TRISSEA) was developed as a mobile application to enhance the commuters' experiences by integrating technological innovations in the app's interface. The study employed an exploratory sequential mixed-methods research design. Qualitative data were gathered through formal interviews with tricycle commuters and drivers to identify issues and concerns that served as the basis for developing the survey instruments. In the quantitative phase of the study, 90 participants were surveyed and assessed the mobile app's net effect on commuters' safety, satisfaction, and usability. The Technology Acceptance Model (TAM) served as the foundation for the quantitative phase of the study. Ten IT experts served as evaluators to measure the app's compliance with ISO 25010 software quality standards. Findings revealed that consumers consistently expressed dissatisfaction with the current tricycle system, particularly regarding safety, fare payment, and the professionalism and behaviour of tricycle drivers. The developed TC-TRISSEA app addressed these concerns through embedded features, including real-time tracking, a feedback mechanism, and driver profile verification using QR codes. The IT experts rated the app as compliant to a "Very Great Extent" with ISO 25010 software quality standards, thus confirming that it is robust and usable. The study revealed that the app significantly enhanced commuter safety and overall satisfaction by addressing the areas of inefficiencies and promoting accountability among drivers. The app's adherence to international software quality standards underscores its potential as a scalable model for urban mobility solutions in cities and municipalities across the Philippines.***

Keywords: Tricycle Transportation System, Mobile Application, Commuter Safety, Urban Mobility Solutions, ISO 25010 Software Standards.

Abbreviations:
TC-TRISSEA: Tricycle Riders Information, Security, and Satisfaction Enhancement App
TAM: Technology Acceptance Model
IT: Information Technology
TRU: Tricycle Regulatory Unit
ETA: Estimated Time of Arrival

I. INTRODUCTION

The need for secure, efficient, and responsive public transportation systems has become increasingly critical in rapidly urbanising areas worldwide. This is especially true in cities where traditional modes of transit, such as tricycles, are a primary means of transportation. Like many urban centres, the town of Tuguegarao in the Philippines relies heavily on tricycles to meet the mobility needs of its residents. However, despite their accessibility and affordability, tricycles in Tuguegarao City have encountered persistent issues related to commuter safety, satisfaction, and accountability due to the lack of standardized protocols and technological integration [1].

The Tuguegarao City Tricycle Riders Information, Security, and Satisfaction Enhancement App (TC-TRISSEA) was developed to address these challenges by providing a secure, user-friendly digital platform that enhances the commuting experience. This app aligns with Sustainable Development Goal 11, which advocates making cities inclusive, safe, resilient, and sustainable (United Nations, 2015).

With the advancement of mobile technology, several studies have highlighted the benefits of mobile applications in improving urban transportation services by providing real-time information, enhancing security, and facilitating commuter feedback [2] The TC-TRISSEA app leverages these capabilities by offering Tuguegarao tricycle commuters with quick access to driver and operator details via QR code technology [3]. Through this system, commuters can scan QR codes within tricycles to obtain vital information about their driver, such as their name, age, and residence, and track their geographic location in real-time, fostering a sense of security. The app also allows commuters to rate their satisfaction and submit feedback on the service provided, creating a

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feedback loop that promotes accountability and continuous improvement in tricycle services [4].

The theoretical foundation of this study is based on the Technology Acceptance Model (TAM), which posits that users' acceptance of a new technology is influenced by their perceptions of its usefulness and ease of use. Applying TAM, this study examines these perceptions among tricycle commuters in Tuguegarao City, assessing how the TC-TRISSEA app impacts their commuting experience, specifically regarding safety and satisfaction. Previous studies underscore the importance of TAM in evaluating new technology adoption in public services, indicating that user acceptance can significantly enhance the success and sustainability of tech-driven solutions in urban mobility [5]. By examining these factors, this study aims to provide valuable insights into how technology can address commuter needs in a culturally and contextually relevant manner, offering evidence for the role of mobile apps in transforming public transportation systems.

The anticipated outcomes of this study hold significant implications for various stakeholders, including local government units, transportation regulatory agencies, and tricycle drivers and operators. By addressing current issues in tricycle commuting, TC-TRISSEA offers a potentially replicable model for integrating technology into public transport in urban areas that rely on non-traditional transit modes. Moreover, the app's feedback mechanism enables local authorities to gather valuable data that could inform policy changes to improve commuter experiences and reinforce safety measures. Ultimately, this study sought to advance the discourse on the role of technology in enhancing urban transport systems, with TC-TRISSEA contributing to a sustainable, responsive, and user-centred approach to addressing the evolving mobility needs of Tuguegarao City's residents.

A. Problem Statement

This research aimed to develop and implement a mobile app for tricycle commuters in Tuguegarao City, enhancing their information, security, and satisfaction during tricycle rides.

Specifically, it sought answers to the following questions:

i. What problems and challenges do the tricycle commuters in Tuguegarao City encounter?
ii. What mobile app can be designed to address the problems and challenges tricycle commuters encounter in Tuguegarao City?
iii. What is the level of satisfaction of the tricycle commuters and operators with the developed mobile app for tricycle commuters in Tuguegarao City?
iv. What are the best features of the developed mobile app for tricycle commuters in Tuguegarao City?
v. What is the extent of compliance of the developed mobile app for tricycle commuters in Tuguegarao City with ISO 25010 software standards, as assessed by the Information Technology (IT) experts in terms of:
   - Functionality;
   - Performance efficiency;
   - Compatibility;
   - Usability;
   - Reliability;
   - Security;
   - Maintainability; and
   - Portability?
vi. What are the comments and suggestions of the tricycle commuters, drivers, and operators to further enhance the mobile app developed for tricycle commuters in Tuguegarao City?

II. METHODOLOGY

A. Research Design

This study employed an exploratory sequential mixed-methods design to evaluate the effectiveness of the Tuguegarao City Tricycle Riders Information, Security, and Satisfaction Enhancement App (TC-TRISSEA) in improving commuter safety and satisfaction. The exploratory sequential mixed methods approach was appropriate for this study, as it allowed the researchers to initially explore the research participants' experiences qualitatively, subsequently informing the development of a quantitative instrument for broader data collection and analysis.

In the study's first phase, qualitative data were gathered through in-depth interviews with a purposive sample of tricycle commuters and drivers in Tuguegarao City. This phase aimed to uncover detailed insights into users' experiences, concerns, and expectations regarding the tricycle commuting system. The interview findings highlighted specific issues related to safety, ease of access to driver information, and overall commuter satisfaction, providing a deeper understanding of the challenges faced by tricycle commuters. These qualitative insights were instrumental in identifying key themes and constructing survey items for the subsequent quantitative phase.

The study's second phase employed a survey-based quantitative approach, involving the development of a structured questionnaire based on the qualitative findings. The questionnaire was designed to measure perceptions of the TC-TRISSEA app's usefulness, ease of use, security features, and impact on satisfaction. Using constructs from the Technology Acceptance Model (TAM) as a guiding framework, the survey assessed user acceptance of the app by capturing data on perceived usefulness, ease of use, and security enhancements. Responses were collected from a larger sample of tricycle commuters in Tuguegarao City, enabling the researchers to validate and generalize the themes identified in the qualitative phase.

Data analysis followed a two-stage process. Qualitative data from the interviews were thematically analysed to derive themes that informed the development of the quantitative survey items. Quantitative data were then analysed using both descriptive and inferential statistics to assess the extent to which the app met the identified needs of

commuters, examining the relationships between app usage, perceived safety, and satisfaction levels. This mixed methods design comprehensively understood TC-TRISSEA's impact on commuter experiences, blending rich qualitative insights with quantifiable outcomes.

B. Participants of the Study

The participants in this study included tricycle commuters and drivers in Tuguegarao City who were involved in various phases of the research. For the qualitative phase, a purposive sampling technique was employed to select a group of 20 tricycle commuters and 10 tricycle drivers who regularly used the city's tricycle services. These participants were chosen based on their familiarity with the local tricycle system and willingness to provide in-depth insights into their experiences, expectations, and concerns regarding commuting. The sample size for the qualitative phase was designed to reach data saturation, where no new themes emerged from the interviews.

In the quantitative phase, a larger sample of tricycle commuters was recruited to assess the generalizability of the qualitative findings. A total of 90 commuters participated in the survey, with the sample size determined using the Raosoft Online Sample Calculator for the sample size estimation, considering the estimated population of tricycle commuters in Tuguegarao City. Participants were selected through convenience sampling to ensure accessibility, while providing a diverse representation of gender, age, and frequency of tricycle use. This sample enabled statistical analysis with sufficient power to detect relationships between app usage, commuter satisfaction, and safety perceptions.

Participants' demographics included age groups, genders, profiles, and commuter frequency levels, reflecting the diversity of tricycle users in Tuguegarao City. These characteristics provided a robust foundation for analyzing the data, ensuring that the study captured a broad spectrum of perspectives on the effectiveness of the TC-TRISSEA app.

C. Instrumentation

This study utilized three primary instruments: a semi-structured interview guide for the qualitative phase, a structured survey questionnaire for the quantitative phase, and a commuter satisfaction survey to assess user satisfaction with the functionality and usability of the TC-TRISSEA app. A separate survey instrument was also developed to evaluate the app's compliance with ISO 25010 standards for software quality.

In the qualitative phase, a semi-structured interview guide was used to gather detailed insights from the participants regarding their commuting experiences, safety concerns, and overall perceptions of the tricycle transportation system in Tuguegarao City. This guide contained open-ended questions and prompts that encouraged participants to discuss their expectations and potential barriers to adopting a mobile app for tricycle services. The flexible nature of this instrument allowed the interviewer to probe further as new themes emerged during the interviews.

A structured survey questionnaire was created for the quantitative phase based on the themes identified in the qualitative phase. This survey was grounded in the Technology Acceptance Model (TAM) and organized into four sections: (1) demographic information, (2) perceived usefulness of the app, (3) perceived ease of use, and (4) impact on commuter safety and satisfaction. Each item was rated on a four-point Likert scale, ranging from "strongly disagree" to "strongly agree," allowing participants to indicate their level of agreement with statements related to their experiences and perceptions of the TC-TRISSEA app.

To assess user satisfaction specifically, a commuter satisfaction survey was administered to measure the mobile app's functionality and ease of use. This survey collected data on user satisfaction across various features, including QR code scanning, driver information accessibility, and the feedback submission process. The commuter satisfaction survey offered additional insights into the app's practical effectiveness and alignment with users' expectations.

To evaluate the app's technical quality, a separate survey was conducted to assess the extent to which the TC-TRISSEA app met ISO 25010 standards, which outline quality standards for software systems. This survey included items aligned with ISO 25010 quality attributes, such as functionality, reliability, usability, efficiency, maintainability, and portability, among others, providing a comprehensive assessment of the app's adherence to international software quality benchmarks.

Experts in software quality, transportation technology, and public administration reviewed each survey instrument to ensure content validity. The questionnaires were pilot-tested with a small group of tricycle commuters, allowing for refinements to improve clarity and ensure reliability. Cronbach's alpha was calculated for each survey section, yielding satisfactory internal consistency scores that confirmed the instruments reliably measured the intended constructs.

D. Data Gathering Procedure

The data gathering for this study followed a sequential process aligned with the exploratory sequential mixed methods design. The study began with qualitative data collection, followed by quantitative surveys that built upon the initial findings.

In the first phase, qualitative data were gathered through in-depth interviews with a purposive sample of tricycle commuters and drivers in Tuguegarao City. Before the interviews, the researchers obtained informed consent from each participant, explaining the study's purpose, confidentiality measures, and their right to withdraw at any point. The interviews were conducted in person at convenient locations for the participants, using a semi-structured interview guide. Each interview was audio-recorded with the participant's permission and lasted approximately 30 to 45 minutes. This qualitative phase provided rich insights

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into the participants' experiences, which informed the design of the subsequent survey instruments.

Following the qualitative phase, a structured survey questionnaire was administered to a larger sample of tricycle commuters to assess the themes identified in the interviews quantitatively. The survey, which included items based on the Technology Acceptance Model (TAM), aimed to measure the perceived usefulness, ease of use, safety features, and overall satisfaction with the TC-TRISSEA app. The survey was distributed both online and in person to ensure accessibility and a higher response rate. Participants were guided on how to complete the questionnaire. In addition to the primary survey, two supplementary surveys were conducted. First, a commuter satisfaction survey was administered to assess users' satisfaction levels with the app's functionality, ease of use, and specific features such as QR code scanning and driver information access. Second, a compliance assessment survey evaluated the app's alignment with ISO 25010 standards, focusing on software quality attributes like functionality, reliability, usability, and efficiency. Both supplementary surveys were distributed alongside the main questionnaire, and participants were instructed to complete each section.

Data collection spanned four weeks to ensure adequate response rates across all survey instruments. Completed surveys were collected, reviewed for completeness, and stored securely. Quantitative data were then entered into SPSS statistical software for analysis, while qualitative data were transcribed and coded for thematic analysis.

By following this structured data-gathering procedure, the researchers ensured that the data collected was comprehensive, reliable, and aligned with the study's objectives. This multi-phase approach provided a robust foundation for evaluating the effectiveness of the TC-TRISSEA app in enhancing commuter safety and satisfaction in Tuguegarao City.

E. Data Analysis

Data analysis for this study was conducted in two stages, reflecting the exploratory sequential mixed methods approach used to assess the effectiveness of the TC-TRISSEA app. In the first stage, qualitative data from interviews were analyzed to identify key themes and insights, which then informed the design of the quantitative instruments. In the second stage, quantitative data from the survey questionnaires were analysed to measure the app's impact on commuter safety and satisfaction, as well as its compliance with ISO 25010 standards.

F. Qualitative Data Analysis

Qualitative data from the in-depth interviews with tricycle commuters and drivers were transcribed verbatim and subjected to thematic analysis. This analysis involved an initial coding process to identify recurring themes related to commuter experiences, safety concerns, and perceptions of the app's features. The researchers reviewed and refined the codes iteratively to develop broader categories that captured the primary concerns and expectations of the participants. Key themes that emerged from this analysis, such as the need for secure driver information and reliable location tracking, were used to develop specific items for the subsequent survey questionnaires. This qualitative phase provided a rich context for understanding the commuters' perspectives, which helped guide the focus of the quantitative analysis.

G. Quantitative Data Analysis

Quantitative data collected from the structured survey questionnaire were analyzed using descriptive statistics. Descriptive statistics were calculated to summarize the participants' ratings of the TC-TRISSEA app's usability, safety features, and satisfaction levels. This analysis provided an overview of general commuter perceptions and satisfaction with app functionality.

H. Commuter Satisfaction and ISO 25010 Compliance

The commuter satisfaction survey data were analyzed to determine user satisfaction with the app's specific features, including QR code scanning, driver information accessibility, and the feedback mechanism. Mean scores were calculated for each feature to gauge overall satisfaction and identify areas for potential improvement.

The ISO compliance survey data was analysed to evaluate the app's compliance with ISO 25010 standards. Mean scores were calculated for each quality attribute (functionality, reliability, usability, efficiency, etc.) to evaluate how well the app met established software quality standards. This compliance assessment provided a technical perspective on the app's performance, complementing the user-focused insights from the commuter satisfaction survey.

Combining thematic analysis with descriptive statistics, this study comprehensively evaluated the TC-TRISSEA app's effectiveness in enhancing commuter safety and satisfaction in Tuguegarao City. This multi-faceted analysis approach ensured that the survey captured both user experiences and technical compliance, offering valuable insights into the app's impact and areas for future enhancements.

III. RESULTS AND DISCUSSION

A. Problems and Challenges Encountered by the Tricycle Commuters in Tuguegarao City

i. Data Obtained from the Questionnaire

A questionnaire was administered to some tricycle commuters in Tuguegarao City to know their experiences as commuters. Table I presents the results of their mean responses.

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Table-I: Commuters' Assessment of their Commuting Experience in Tuguegarao City

Statement	Mean	DI
1. I feel safe from harm when I ride a tricycle.	3.94	Strongly Disagree
2. Most of the time, I do not have difficulty finding a tricycle to ride in Tuguegarao City.	3.72	Strongly Disagree
3. Riding a tricycle provides convenience, and I feel comfortable as a passenger.	3.61	Strongly Disagree
4. Tricycle drivers in Tuguegarao respect traffic laws and city regulations.	3.47	Strongly Disagree
5. Most tricycle drivers are helpful to their passengers.	3.64	Strongly Disagree
6. Tricycle drivers charge only the correct fare based on the passenger's destination.	3.50	Strongly Disagree
7. Tricycle drivers offer discounts to students, senior citizens, and passengers with disabilities.	3.81	Strongly Disagree
8. Tricycle drivers in the city give the correct change.	3.53	Strongly Disagree
9. Tricycle drivers in Tuguegarao do not overcharge passengers.	3.72	Strongly Disagree
10. Tricycle drivers in Tuguegarao do not demand excessive payment from passengers.	3.72	Strongly Disagree
11. Tricycle drivers do not discriminate against passengers based on their appearance.	3.64	Strongly Disagree
12. Tricycle drivers in Tuguegarao do not choose their passengers.	3.44	Strongly Disagree
13. The driver of the tricycle I ride does not charge extra for 'capacity' or 'double pay.'	3.53	Strongly Disagree
14. The tricycle driver refrains from smoking while operating the tricycle.	3.86	Strongly Disagree
15. Tricycle drivers wear clean and proper attire while operating their vehicles.	3.86	Strongly Disagree
16. Tricycle drivers are courteous to their passengers.	3.89	Strongly Disagree
17. Tricycle drivers keep their tricycles clean and tidy.	3.89	Strongly Disagree
18. Tricycle drivers in Tuguegarao do not drive recklessly.	3.69	Strongly Disagree
19. Tricycle drivers in Tuguegarao do not carry more passengers than the vehicle's capacity allows.	3.61	Strongly Disagree
20. An identification card is displayed inside the tricycle for the driver's identification.	3.60	Strongly Disagree
21. Tricycle drivers do not take advantage of passengers who are not from Tuguegarao.	3.61	Strongly Disagree
22. Tricycle drivers in Tuguegarao are cheerful and talkative.	3.89	Strongly Disagree
23. Tricycle drivers charge a fare based on the passenger's destination.	3.83	Strongly Disagree
24. Tricycle drivers comply with the end-number coding regulations to help alleviate traffic problems in the city.	3.86	Strongly Disagree
25. Tricycle drivers do not take unnecessary detours to overcharge their passengers for the fare.	3.92	Strongly Disagree
Category Mean	3.72	Strongly Disagree

Table I reflects the commuters' assessment of their commuting experience in Tuguegarao City, highlighting the significant challenges that tricycle passengers face. The overall category mean of 3.72, interpreted as "Strongly Disagree," indicates widespread dissatisfaction with their commuting experiences.

The statement "I feel safe from harm when I ride a tricycle" received a mean of 3.94, showing that safety is a significant concern among commuters. Safety is a critical factor for any mode of public transportation, and the lack of perceived safety may deter people from relying on tricycles as a primary means of transit. Additionally, the difficulty in finding available tricycles (mean = 3.72) exacerbates commuting stress, pointing to inefficiencies in the tricycle system's accessibility and availability.

Statements related to tricycle drivers' behaviour and compliance with regulations also received low ratings. For instance, "Tricycle drivers in Tuguegarao respect traffic laws and city regulations" garnered a mean of 3.47. In contrast, the perceived fairness of fare charges ("Tricycle drivers charge only the correct fare based on the passenger's destination") received a score of 3.50. These findings suggest issues of driver accountability and adherence to policies. Passengers also expressed dissatisfaction with drivers' attitudes and actions, such as discrimination against passengers (mean = 3.64), the absence of ID displays (mean = 3.60), and concerns about reckless driving (mean = 3.69). These results highlight the need for systemic reforms to improve service quality and foster trust between drivers and commuters.

Hygiene and appearance-related factors also received poor assessments, with "Tricycle drivers keep their tricycles clean and tidy" and "Tricycle drivers wear clean and proper attire while driving" scoring 3.86. These indicate unmet expectations regarding the cleanliness and professionalism of drivers.

The findings underscore the urgent need for a transformative solution to address the challenges faced by tricycle commuters in Tuguegarao City. Developing a mobile app, such as the proposed TC-TRISSEA, could provide a platform to address these concerns effectively. The app could integrate features such as real-time tracking of tricycles to improve accessibility and availability. It could also include a fare calculator to ensure transparency in pricing and prevent overcharging, thereby addressing concerns about fairness and affordability.

Moreover, the app could incorporate a driver rating system to encourage accountability and professionalism. Passengers could rate drivers based on their experiences, providing feedback on safety, compliance with traffic laws, cleanliness, and courteousness. This feedback could incentivise better behaviour among drivers and enable regulatory bodies to monitor service quality.

Safety concerns could be addressed by integrating features that verify drivers' identities through in-app profiles, complemented by requiring visible ID displays in tricycles. These measures would enhance commuter trust and confidence. Additionally, the app could provide a mechanism for passengers to report violations or incidents, such as reckless driving or discrimination, enabling prompt action to be taken.

The poor assessments of commuting experiences highlight a pressing need for interventions to improve the quality of tricycle services in Tuguegarao City. The development of TC-TRISSEA could be a strategic tool to enhance commuters' safety, convenience, and overall satisfaction. This approach aligns with global trends in leveraging technology to modernize urban transportation systems and improve commuter experiences [6].

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ii. Data Obtained from Literature Review and Interview

To triangulate and validate the questionnaire findings, information from the literature
Review and interviews revealed the following thematic problems and challenges encountered by tricycle commuters in Tuguegarao City.

- *Traffic Congestion and Overcrowding*

Tricycle commuters in Tuguegarao City encounter various interrelated problems and challenges that significantly affect their daily transportation experiences. Among these issues is the persistent traffic congestion and overcrowding, primarily attributed to the proliferation of registered and unregistered tricycles. With an estimated 9,000 tricycles operating within the city, road congestion has become a serious concern, leading to extended travel times and inefficiencies in mobility

- *Environmental and Health Concerns*

The environmental impact of this mode of transportation is another pressing issue. A substantial number of tricycles are powered by two-stroke engines, which are known for higher emissions, contributing to air and noise pollution that raises environmental and public health concerns (Philippine Journal of Science, n.d.).

- *Safety and Security Issues*

Safety and security concerns are also prevalent, particularly with unregistered or 'colorum' tricycles. These unauthorised vehicles often compromise commuter safety as they operate without proper oversight, leading to incidents where drivers exhibit discourteous behaviour or arbitrarily choose passengers (Northern Forum, n.d.).

- *Service Quality and Driver Conduct*

Service quality further exacerbates the challenges faced by commuters. Many participants verbally reported dissatisfaction due to reckless driving and varying levels of professionalism among drivers, which directly impact the overall commuting experience (Seybold Report, n.d.).

- *Regulatory and Compliance Challenges*

Regulatory and compliance challenges also undermine the tricycle transportation system. The Tricycle Regulatory Unit (TRU) struggles to enforce regulations effectively due to its limited resources, which hampers efforts to monitor compliance and maintain an updated database of drivers and operators (Graph.co.uk, 2018b).

- *Modernization and Financial Constraints*

Efforts toward modernization, such as transitioning to environmentally friendly vehicles, face resistance due to financial constraints among drivers and operators. Many are unprepared for the associated costs, highlighting the need for supportive policies to facilitate a smoother transition (Freiheit.org, 2021).

Addressing these challenges requires a multifaceted approach, including enhancing regulatory frameworks, providing driver training programs, investing in sustainable transportation solutions, and fostering collaboration between local authorities, drivers, and commuters. Tuguegarao City can create a safer, more efficient, and environmentally responsible tricycle transportation system by addressing these interconnected issues.

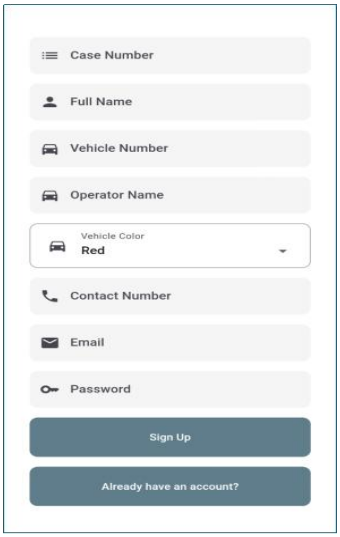
B. Proposed Mobile App to Address Some Selected Problems and Challenges Encountered by the Tricycle Commuters in Tuguegarao City

i. Getting Started

- *Download the TC-Trissea App*

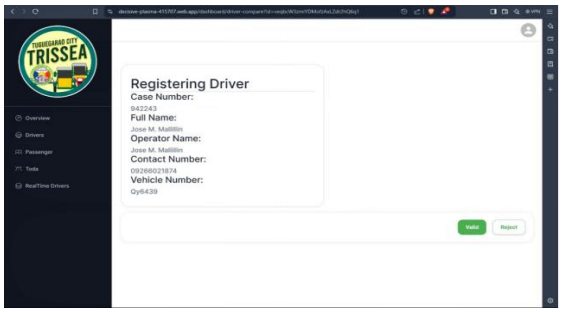
The Application is downloaded through the Google Play Store since the Android OS powers it.

ii. Create a Driver's Account



[Fig.1: Drivers Account]

The Driver shall input all the information needed to create the account.



[Fig.2: Driver Registration]

Figure 2 presents the driver registration. The Tricycle Regulation Unit (TRU) requires the system

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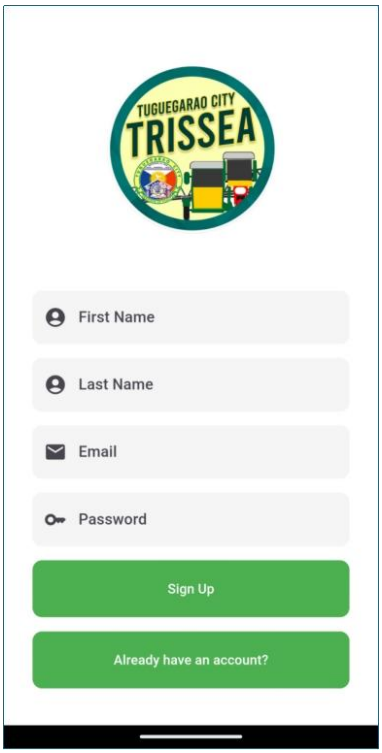
administrator to accept the information and application for the account.

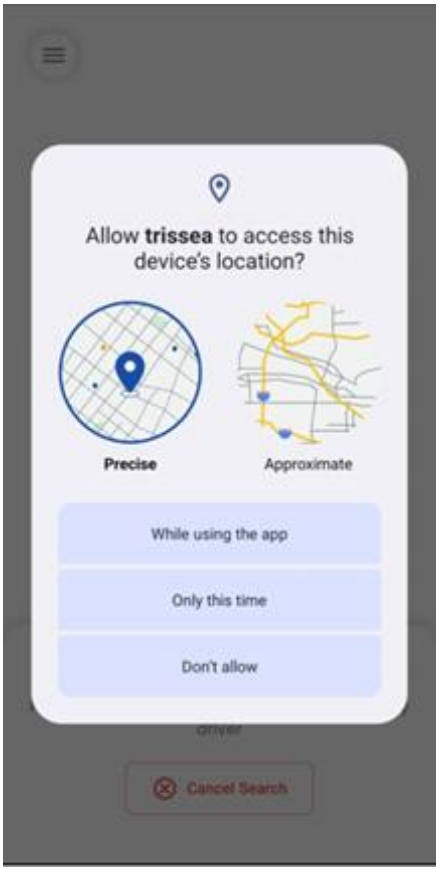
iii. Create a Rider's Account (Rider)



[Fig.3: Riders Account]

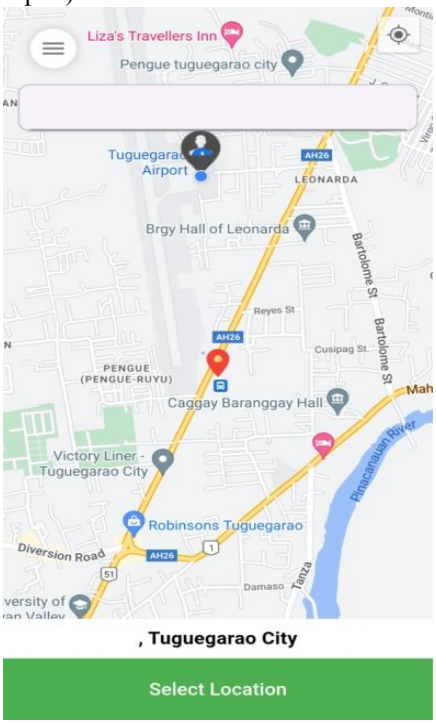
Figure 3 allows the riders to input all necessary information needed and check their email for verification

iv. *Booking A Tricycle*



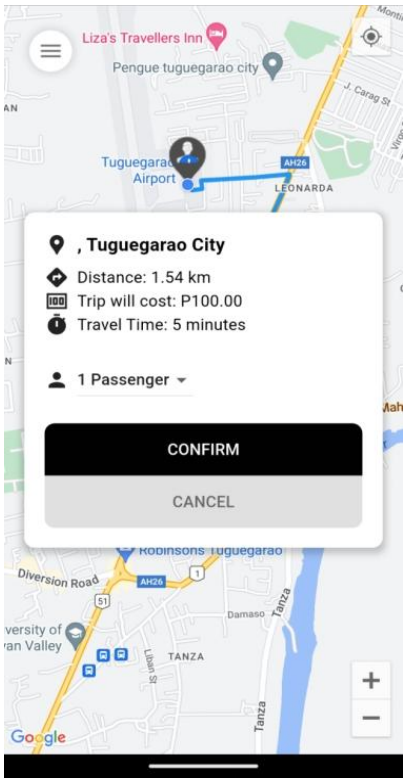
[Fig.4: Booking a Tricycle]

Figure 4 allows the app to access the commuter's location or manually enter his/her pickup location. (Adjust the location pin if necessary to ensure the tricycle will arrive at the correct spot.)



[Fig.5: Choose Tricycle Service]

Figure 5 allows riders to look for the Tricycle option among the listed transport modes. Tap on Tricycle to select one's preferred ride type.



[Fig.6: Commuters Destination]

Figure 6 displays the commuter destination address or location he/she wants to go, then reviews the fare

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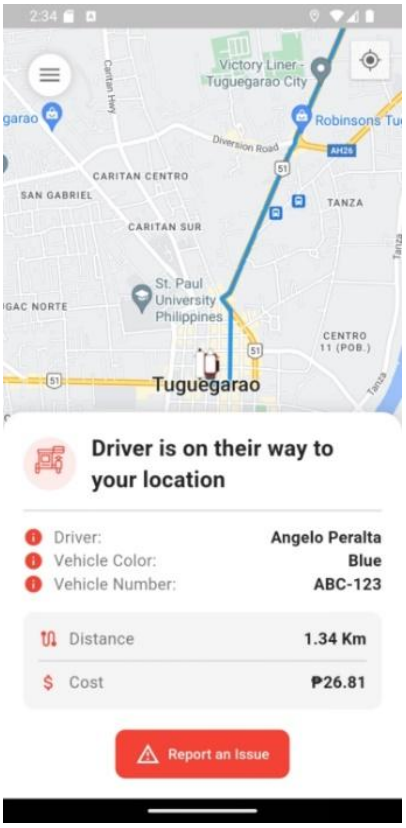
estimate (if available) for the tricycle service before proceeding and confirms the destination. Once a driver accepts your request, you'll see their details, including name, tricycle plate number, and estimated arrival time.



[Fig.7: Drivers Map]

Figure 7 Displays the pickup location as indicated in the app. (You can contact the driver through the in-app messaging or call option if needed.)

v. In-Ride Features

- Live Location Tracking
- Real-Time Updates: The app displays the commuter's current location on a map as soon as a commuter tricycle ride begins.
- Track One's Journey:
- The moving icon represents the tricycle's real-time position.
- The commuter can monitor the route to ensure it aligns with the expected path to his destination.
- Adjustments and Notifications:
- If unexpected detours or delays occur, the app may update the route and ETA accordingly.
- The commuter must be informed about any changes that may occur during their trip.
- Driver Details and Contact
- On the ride details screen, the commuter views the driver's name, photo, and tricycle details, such as the plate number or identification markings.
- ETA and Route Information
- Estimated Time of Arrival (ETA):
- The app provides an estimated arrival time, showing how long it will take to reach your destination.
- The ETA updates in real-time based on current traffic and route conditions.
- Route Information:
- The app displays the planned route, showing turns and stops along the way.
- The commuter can monitor the journey's progress, remaining distance, and potential detours.

vi. Safety Features

- Safety Tips & Managing Bookings
- Before boarding, the commuter must confirm that the tricycle's details, including the driver's name and plate number, match those shown in the app.
- Before the ride begins, the commuter must double-check their pickup and drop-off points in the app to ensure accuracy.
- Cancelling a Ride:
- Cancel Option:
- If the commuter needs to cancel his booking, he can tap the Cancel Ride option in the app before the driver accepts the ride.
- Rebook if Necessary:
- If the commuter cancels a ride due to driver unavailability or delays, they can rebook by selecting the tricycle option again.

vii. Fare And Payment

- Fare Review and Paying the Fare
- Payment is in cash. (The commuter hands the driver the exact amount or any extra change.)
- Reviewing Receipt:
- After payment, the commuter can view a digital receipt in the app that details the fare amount and the payment method used.
- The commuter can access this receipt later for reference if needed.

viii. Customer Support

- **Reporting Issues**

Step 1: Access the Help Centre or Support section of the app.

Step 2: Choose the trip where the commuter encountered an issue from his ride history.

Step 3: The commuter describes the issue, selects from common topics (e.g., fare discrepancies, driver behavior, lost items) or describes his problem in detail.

Step 4: The commuter follows the prompts to provide additional information if needed and submit the report.

(After submitting, the app's support team will typically follow up with the commuter through in-app notifications or email to address your concern.)

- **Rating the Commuter's Driver**

Step 1: Once your trip ends, a prompt will appear to rate your driver, usually on a scale from 1 to 5 stars.

Step 2: You may also be able to add comments or choose specific feedback categories (e.g., driving style, vehicle cleanliness, punctuality).

Step 3: If your experience was excellent, consider leaving a positive review to recognize the driver's effort. Many ride-hailing apps reward drivers with high ratings.

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C. Operators with the Developed Mobile App for Tricycle Commuters in Tuguegarao City

Table-II: Tricycle Commuters and Operators' Level of Satisfaction with the Developed Mobile App in Terms of Its Accessibility and Usability

Items	Mean	Qualitative Description
1. The app is easy to navigate and user-friendly.	3.51	Very Satisfied
2. The app's design and layout are visually appealing and intuitive.	3.42	Very Satisfied
3. Information about tricycle drivers and operators is accessible through the app.	3.53	Very Satisfied
4. QR code scanning is a reliable and efficient method for data transmission.	3.43	Very Satisfied
5. The app performs well, with minimal crashes or glitches.	3.43	Very Satisfied
6. The app provides timely updates and notifications.	3.49	Very Satisfied
Category Mean	3.47	Very Satisfied

Table-III: Tricycle Commuters and Operators' Level of Satisfaction with the Developed Mobile App in Terms of Its Safety and Security Features

Items	Mean	Qualitative Description
1. The app enhances the commuters' sense of safety when commuting.	3.51	Very Satisfied
2. The ability to track the tricycle's geographic location during the ride enhances security.	3.47	Very Satisfied
3. The app makes it easy to verify the identity of the tricycle driver or operator.	3.53	Very Satisfied
4. Commuters feel more secure using tricycles, knowing that the app records trip details.	3.53	Very Satisfied
5. The app effectively prevents unauthorized or 'colorum' tricycle operations.	3.55	Very Satisfied
Category Mean	3.52	Very Satisfied

Table-IV: Tricycle Commuters and Operators' Level of Satisfaction with the Developed Mobile App in Terms of Service Quality and Feedback Mechanism

Items	Mean	Qualitative Description
1. The app enables convenient submission of feedback about tricycle services.	3.55	Very Satisfied
2. Drivers/operators promptly address complaints raised through the app.	3.45	Very Satisfied
3. The app improves the overall quality of tricycle commuting services.	3.38	Very Satisfied
4. The app ensures a fair and accurate driver rating system.	3.45	Very Satisfied
5. The commuter feels confident that his/her feedback is valued and considered by relevant authorities.	3.51	Very Satisfied
Category Mean	3.47	Very Satisfied

Table-V: Tricycle Commuters and Operators' Level of Satisfaction with the Developed Mobile App in Terms of Its Environmental and Social Impact

Items	Mean	Qualitative Description
1. The app promotes using environmentally friendly practices in tricycle operations.	3.57	Very Satisfied
2. The app encourages responsible driving behavior among tricycle drivers.	3.45	Very Satisfied
3. The commuter believes that the app helps reduce pollution and congestion in the city.	3.45	Very Satisfied
4. The app fosters a stronger community between commuters and operators.	3.45	Very Satisfied
Category Mean	3.48	Very Satisfied

Table-VI: Tricycle Commuters and Operators' Level of Satisfaction with the Developed Mobile App in Terms of Overall Satisfaction

Items	Mean	Qualitative Description
The app has met my expectations for improving tricycle commuting in Tuguegarao City.	3.42	Very Satisfied
The app has significantly enhanced my commuting experience.	3.51	Very Satisfied
I am satisfied with the app's overall performance.	3.42	Very Satisfied
I would recommend this app to other tricycle commuters and operators.	3.43	Very Satisfied
Category Mean	3.44	Very Satisfied

The assessment of tricycle commuters' and operators' satisfaction with the developed TC-TRISSEA app reveals positive reception across multiple dimensions. The findings indicate that the app effectively addresses key concerns related to accessibility, usability, safety, security, service quality, environmental impact, and overall satisfaction.

i. Accessibility and Usability

Table I shows that the accessibility and usability of the TC-TRISSEA app received a category mean of 3.47, interpreted as "Very Satisfied." The highest-rated item, "Information about tricycle drivers and operators is accessible through the app" (mean = 3.53), suggests that the app successfully provides a reliable platform for users to verify driver details, reinforcing commuter trust. Additionally, the ease of navigation (mean = 3.51) and the reliability of QR code scanning (mean = 3.43) indicate that users find the app user-friendly and intuitive. This supports the broader literature on the importance of seamless user experience in transportation apps, where accessibility and interface design significantly influence user engagement [1]. These results suggest that the app has met its objective of enhancing commuter convenience through a well-designed digital solution.

ii. Safety and Security Features

Table II reveals that the app's safety and security features received a category mean of 3.52, indicating high satisfaction. Notably, preventing unauthorised or 'colorum' tricycle operations (mean = 3.55) and verifying tricycle drivers' identities (mean = 3.53) emerged as key strengths of the application. The app's ability to track the geographic location of the tricycle during the ride (mean = 3.47) also reinforces security, aligning with previous studies emphasizing the role of GPS-enabled technology in enhancing commuter safety [7]. These findings suggest that TC-TRISSEA successfully fosters a sense of security among commuters, making tricycle rides more transparent and accountable.

iii. Service Quality and Feedback Mechanism

Table III presents the service quality and feedback mechanism, which received an overall category mean of 3.47, reflecting intense satisfaction. The highest-rated item, "The app enables convenient feedback submission about tricycle services" (mean = 3.55), highlights the importance of incorporating commuter feedback into transportation solutions. Meanwhile, confidence that authorities value feedback (mean = 3.51) and the

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fairness of the driver rating system (mean = 3.45) suggest that users perceive the app as a tool for fostering accountability. These findings align with studies that emphasise the impact of digital feedback mechanisms in improving public transportation services by allowing users to voice their concerns and share experiences (Guo et al., 2018).

iv. Environmental and Social Impact

Table IV indicates that the environmental and social impact of the app received a category mean of 3.48, indicating a delighted response from users. The highest-rated item, "The app promotes the use of environmentally friendly practices in tricycle operations" (mean = 3.57), suggests that users recognize the app's potential in contributing to sustainable transport initiatives. Additionally, promoting responsible driving behaviour (mean = 3.45) and reducing pollution and congestion (mean = 3.45) underscore the app's broader impact, extending beyond commuter convenience. These findings support global efforts to integrate innovative technologies into urban mobility systems to encourage eco-friendly practices and reduce carbon footprints [3]

v. Overall Satisfaction

Table V consolidates the overall perception of the app, with a category mean of 3.44, indicating that commuters and operators are very satisfied. The app's ability to enhance the commuting experience (mean = 3.51) and the high likelihood of recommendation (mean = 3.43) suggest strong acceptance and perceived value among users. These findings underscore the success of TC-TRISSEA in addressing key transportation challenges in Tuguegarao City and demonstrate its potential for broader implementation.

The consistently high satisfaction ratings across all measured dimensions indicate that TC-TRISSEA is a viable urban mobility solution for enhancing the safety, efficiency, and service quality of tricycle commuting. The app's integration of real-time tracking, driver identification, digital feedback mechanisms, and environmental sustainability features aligns with best practices in smart transport innovations [2]. Moving forward, further enhancements, such as expanding real-time route optimisation and integrating AI-driven safety alerts, could elevate the app's utility.

These results provide a strong basis for policy recommendations to modernise the tricycle transportation system in Tuguegarao City, potentially setting a precedent for similar initiatives in other urban areas. Future research could investigate the longitudinal effects of the app's adoption and assess its role in influencing driver compliance and commuter safety over time.

D. Best Features of the Developed Mobile App for Tricycle Commuters in Tuguegarao City

The Tuguegarao City Tricycle Riders Information, Security, and Satisfaction Enhancement App (TRISSEA) boasts several standout features that enhance the commuting experience for tricycle passengers and drivers. These features can be grouped into the following thematic areas:

i. Ride Booking and Fare Management

One of the app's standout features is its user-friendly ride booking system, which enables passengers to book rides or locate nearby drivers with ease. After specifying their pick-up and drop-off locations, the app calculates the fare based on trip distance and provides the amount upfront, ensuring transparency. During emergencies, such as typhoons, the app incorporates a dynamic fare management system that allows for adjustments, ensuring fairness and compliance with special fare rates enforced by the Tricycle Regulatory Unit (TRU). Additionally, the app applies automatic discounts for students and persons with disabilities, promoting inclusivity and equity in public transportation services.

Integrating user-friendly ride booking systems and transparent fare management is crucial in enhancing public transport usage. A study by [8]. emphasises that improving service performance and information accessibility plays an essential role in increasing public transport patronage.

ii. Safety and Security Enhancements

Safety is a central aspect of TRISSEA's design. Verified driver profiles and QR codes displayed inside tricycles allow passengers to cross-check driver and vehicle information for their peace of mind. Real-time tracking further enhances security by enabling passengers to monitor their trips, reducing the risks of navigation-related disputes or safety concerns. Safety features such as real-time tracking and incident reporting are vital for commuter confidence. The Federal Transit Administration's Enhanced Transit Safety and Crime Prevention Initiative highlights the importance of such measures in ensuring passenger security (https://www.transit.dot.gov/regulations-and-programs/safety/enhanced-transit-safety-and-crime-prevention-initiative?). A built-in reporting feature empowers users to report incidents or unsafe practices, facilitating swift action and reinforcing trust between commuters and drivers.

iii. Feedback and Performance Monitoring

The app features a feedback mechanism that allows passengers to rate their ride experience and provide comments. This feature enables continuous improvement in service quality by offering actionable insights for tricycle drivers and operators. The TRU leverages this data to monitor driver performance, address recurring concerns, and make informed decisions about license renewals. Incorporating feedback mechanisms allows for continuous improvement in service quality. Research indicates that user satisfaction surveys are instrumental in identifying areas needing enhancement, thereby improving overall public transport systems [16].

iv. Transparent Service and Productivity Monitoring

TRISSEA also tracks the number of trips each driver completes, promoting transparency and efficiency. This monitoring capability ensures fair distribution of rides and provides data to evaluate the overall productivity of tricycle operators. Such features are crucial for modernising public transportation systems in urban settings, thereby contributing to operational sustainability and system optimisation.

Utilizing technology to monitor service delivery and productivity ensures accountability and efficiency. The implementation of interactive intelligent systems in public transport facilities has been shown to optimize operations and enhance user satisfaction [17].

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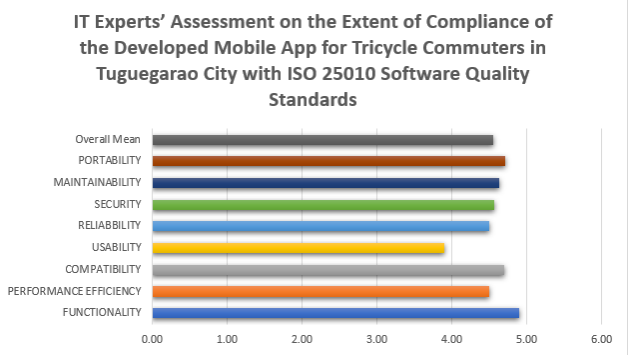
v. Adaptive Fare Customization

The app's ability to dynamically customise fares for specific barangays or during emergencies showcases its adaptability to local contexts. This feature ensures that the system remains responsive to the unique needs of Tuguegarao City, enhancing its functionality and user experience. Additionally, adapting fare structures to meet the specific needs of different community groups, including those with varying user needs, is essential. Studies have shown that transparent and fair fare policies contribute significantly to user satisfaction and the attractiveness of public transport services [15].

E. IT Experts' Assessment on the Extent of Compliance of the Developed Mobile App for Tricycle Commuters in Tuguegarao City with ISO 25010 Software Quality Standards

Table-VII. Summary of the Results of the IT Expert's Evaluation on the Extent of Compliance of the Developed System with the ISO 25010 Software Quality Standards

Attributes	Mean	Descriptive Interpretation
Functional Suitability	4.90	Very Great Extent
Performance Efficiency	4.50	Very Great Extent
Compatibility	4.70	Very Great Extent
Usability	3.90	Great Extent
Reliability	4.50	Very Great Extent
Security	4.56	Very Great Extent
Maintainability	4.63	Very Great Extent
Portability	4.43	Very Great Extent
Category Mean	4.52	Very Great Extent



[Fig.8: Extent of Compliance of the Developed Mobile App for Tricycle Commuters in Tuguegarao City with ISO 25010 Software Quality Standards]

The IT experts' assessments of the extent to which the developed mobile app for tricycle commuters in Tuguegarao City complies with ISO 25010 software quality standards reveal promising results across various dimensions of software quality. Based on specific attributes within each dimension, these assessments demonstrate the app's strong alignment with international standards.

Functionality (Table VI) received a category mean of 4.90, indicating a "Very Great Extent" of compliance. This highlights that the app effectively meets user needs, covering specified tasks and objectives with precision. Functional correctness and appropriateness further validate the app's usability in real-world scenarios. High functionality is crucial for user trust and system reliability, as supported by studies emphasizing software precision in transportation systems [9].

Performance efficiency (Table VII) also scored highly, with a category mean of 4.50. Attributes such as time behaviour and resource utilisation demonstrate the app's ability to operate swiftly and efficiently, which is vital in dynamic commuter environments. Studies on transport mobile apps have underscored the importance of response time and resource optimization for user satisfaction [10].

In terms of compatibility (Table VIII), a category mean of 4.70 reflects the app's seamless interaction with other systems, ensuring interoperability and co-existence. This feature is critical for integrating the app into Tuguegarao City's existing transportation infrastructure, as interoperability enhances system utility and adaptability in complex environments [9].

Usability (Table IX) received a slightly lower category mean of 3.90, with appropriateness, recognizability, and learnability rated highest. However, user error protection scored 3.80, suggesting room for improvement. Addressing this could enhance user experience, as studies note that intuitive design reduces cognitive load and error rates [11].

The app also demonstrated reliability (Table X), with a category mean of 4.50. Attributes such as availability, fault tolerance, and recoverability underscore the app's robustness in ensuring uninterrupted service. Reliability is particularly vital for transportation apps, where consistent functionality can directly impact commuter trust [12].

Regarding security (Table XI), a category mean of 4.56 highlights the app's capability to safeguard user data, ensuring confidentiality and integrity. These findings align with the increasing emphasis on data protection in mobile applications, as highlighted in recent literature on app security [6].

Maintainability (Table XII) achieved a high category mean of 4.63, emphasizing the app's modularity, reusability, and analyzability. However, modifiability and testability received scores of 3.70, indicating areas where further refinement is needed to enhance flexibility and error detection during updates. Maintainability is crucial for long-term usability and cost-effective updates [13].

Finally, portability (Table XIII) scored a category mean of 4.43, reflecting the app's adaptability to different environments. High portability ensures the app remains effective amidst evolving hardware and software ecosystems, a critical factor for scalability and user retention [14].

The developed system generally complied with the ISO/IEC 25010 Software Quality Standards to a "Very Great Extent" regarding functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability.

Figure 8 synthesizes these findings, illustrating the app's comprehensive compliance with ISO 25010 standards. This visualisation underscores the app's strengths, particularly in terms of functionality, reliability, and security, while highlighting potential areas for improvement, such as usability and maintainability.

The assessments affirm the app's capability to enhance the commuter experience in Tuguegarao City. By addressing identified areas for improvement, the app could further solidify its role as an

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innovative solution in urban transportation.

F. Comments and Suggestions of the Tricycle Commuters, Drivers and Operators to Further Enhance the Developed Mobile App for Tricycle Commuters in Tuguegarao City

The feedback from tricycle commuters, drivers, and operators regarding the TC-TRISSEA mobile app includes a mix of positive affirmations, usability improvements, and additional feature requests. The responses can be grouped into several key themes:

i. Enhanced Monitoring and Tracking Features

Several participants suggested real-time tracking of available tricycles and a dashboard to monitor active drivers and completed rides. These enhancements could increase efficiency and transparency, allowing commuters to plan their trips more effectively. Studies on intelligent transportation systems have demonstrated that real-time tracking reduces passenger waiting times and improves overall transport reliability (Guo et al., 2018).

ii. Improved Driver Conduct and Accountability

Some feedback emphasised the need for improved driver conduct reporting, a comprehensive transit program, and a computerised monitoring system. Additionally, commuters want a fair pricing mechanism, with one stating, "*kailangan po muna nilang* ayusin *yung singil nila" (they need to fix their fare charges first*)." These insights suggest a need for stricter regulation and enforcement mechanisms to ensure that tricycle operators provide fair and ethical services.

iii. Integration of Cashless Payment Options

Several commuters expressed interest in digital payment systems such as Venmo, PayPal, and GCash. Digital payments have become a crucial feature of modern transportation apps, allowing faster transactions and reducing the reliance on cash. Research has shown that incorporating cashless transactions enhances commuter convenience and safety while promoting financial transparency [3].

iv. Network Stability and System Reliability

Some users noted that network stability could be improved, ensuring the app remains functional in areas with weak connectivity. Others suggested continuous updates and system improvements to enhance the user experience over time. Ensuring a robust technical infrastructure is critical for the success of mobile applications in public transportation, as reliability directly affects commuter trust [2].

v. Community Awareness and App Promotion

A few participants emphasized the importance of properly introducing the app to barangays and schools to increase adoption. Raising awareness through educational campaigns could help more commuters and drivers become familiar with the app's features, leading to higher usage rates and maximizing its impact on the transportation system.

IV. CONCLUSION

TRISSEA's combination of robust safety measures, efficient ride booking, feedback integration, and dynamic fare management sets it apart as a modern, user-centric platform. By addressing key commuter concerns and streamlining operations for drivers and operators, the app elevates the standard of public transportation in Tuguegarao City. It enhances commuter satisfaction and aligns with broader efforts to modernize urban mobility systems through technological innovation.

The findings of this study underscore the critical role of technology in addressing the persistent challenges of tricycle commuting in Tuguegarao City. The proposed TC-TRISSEA app has demonstrated its potential to significantly enhance commuter safety, satisfaction, and operational efficiency by leveraging innovative features, including real-time tracking, transparent fare management, and a robust feedback mechanism. The app's compliance with ISO 25010 software quality standards, as validated by IT experts, confirms its reliability, functionality, and user-centred design.

Commuters' dissatisfaction with the current tricycle system, characterised by issues of safety, service quality, and driver professionalism, underscores the need for implementing transformative solutions. TC-TRISSEA addresses these gaps by fostering accountability through driver ratings, enhancing accessibility via digital ride booking, and promoting fair pricing through a dynamic fare calculator. Furthermore, the app's emphasis on user feedback and continuous service monitoring ensures a sustainable mechanism for enhancing the commuting experience.

The study also aligns with global trends in urban mobility, illustrating the applicability of the Technology Acceptance Model in predicting user engagement with transport technologies. Integrating innovative solutions like TC-TRISSEA aligns with the Sustainable Development Goals and sets a precedent for modernizing public transport in other cities that rely on traditional modes of transportation.

Ultimately, this research contributes to the growing discourse on technology-driven urban mobility solutions, providing actionable insights for policymakers, local governments, and transportation stakeholders. By addressing commuter concerns and streamlining driver operations, TC-TRISSEA offers a replicable model for integrating technology into public transportation systems, paving the way for safer, more efficient, and sustainable urban transit in Tuguegarao City and beyond.

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DECLARATION STATEMENT

After aggregating input from all authors, I must verify the accuracy of the following information as the article's author.

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- **Data Access Statement and Material Availability:** The adequate resources of this article are publicly accessible.
- **Author's Contributions:** The authorship of this article is contributed equally to all participating individuals

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Philippines (SPUP), she plays a pivotal role in shaping the IT curriculum to align with technological advancements and the evolving needs of the workforce. Dr. Gumabay's leadership in curriculum development ensures that students gain both technical expertise and critical thinking skills necessary for success in a tech-driven world. Her commitment to academic excellence is evident in her research, which has been published in esteemed international journals, contributing to the advancement of educational practices and the future of IT in teaching and learning. Through her work, Dr. Gumabay is dedicated to empowering educators and enhancing learning experiences for students by integrating cutting-edge technologies.

Dr. Sheena Guzman-Gumarang is a dedicated and passionate IT educator with over 10 years of experience teaching and mentoring students in Information Technology. Known for her commitment to shaping the next generation of IT professionals, Dr. Guzman-Gumarang is driven by the mission of equipping students with technical proficiency and critical problem-solving abilities required in today's fast-paced digital world. Dr. Guzman-Gumarang is a certified Microsoft Certified Educator (MCE) and a strong advocate for digital literacy. In addition to her teaching career, Dr. Guzman-Gumarang is a dedicated researcher, focusing on the impact of educational technology on student success. She has actively contributed to numerous research projects, participated in academic conferences, and published research papers that explore emerging trends in IT education and digital teaching and learning tools.