JEEP-PS: ENHANCING MODERN PUBLIC UTILITY JEEPNEY OPERATIONS THROUGH ADVANCED TRACKING AND ARRIVAL INFORMATION FOR THE IFUGAO TRANSPORT SERVICE COOPERATIVE

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ABSTRACT

JEEP-PS: Enhancing Modern Public Utility Jeepney Operations through Advanced Tracking and Arrival Information for the Ifugao Transport Service Cooperative" was designed to modernize and streamline jeepney operations. This project introduced a system that provides advanced tracking and accurate arrival information, improving operational efficiency and commuter experience. The goal was to create a platform that addresses the needs of administrators, operators, drivers, and commuters while ensuring ease of use and reliability. The researchers adopted the Prototype Model, a development methodology emphasizing iterative design and continuous stakeholder feedback. Data collection methods included interviews, questionnaires, and observation to gather insights on system requirements and challenges in current jeepney operations. The study engaged one administrator, one operator, two drivers, ten commuters, and one IT expert, selected through purposive sampling. The system was developed using React.js, Node.js, Express, MongoDB, CSS3, and C++, with development carried out on Visual Studio Code. Hardware components included Arduino Uno, SIM-900A, GPS module, GPS antenna, and LCD module, integrated to ensure precise data collection and user interaction. A web server was implemented to manage system operations and data exchange effectively. The researchers believe that the JEEP-PS system will significantly enhance public transport management by providing advanced tools for tracking, route planning, and commuter information. By leveraging modern technology, the system offers improved reliability and service quality for the Ifugao Transport Service Cooperative and its users.

Keywords: Arduino Uno, GSM Module, GPS Module, Public Utility Jeepney

RATIONALE

Jeepneys, widely regarded as the lifeblood of Philippine transportation, have their origins in World War II, when surplus U.S. military vehicles were repurposed by Filipinos. Ingenious and resourceful, early jeepney operators transformed these vehicles into iconic public transport by adding metal roofs for protection, stretching their chassis for added capacity, and adorning them with vibrant colors and intricate designs. Over the decades, jeepneys have transcended their utilitarian function, becoming cultural symbols that reflect the resilience, creativity, and ingenuity of the Filipino people. Their colorful exteriors often depict cultural themes, religious imagery, or everyday Filipino life, making them a moving canvas of the nation's heritage (Rabino, 2021; Escalona, 2023).

Beyond their cultural significance, jeepneys remain an indispensable mode of transportation for millions of Filipinos. Known for their affordability, efficiency, and accessibility, jeepneys operate around the clock, serving both urban and rural areas. However, the people who drive these vehicles, while providing an essential service, often face economic hardships, with many belonging to the country's lower socioeconomic groups (Andalecio et al., 2020; Enriquez et al., 2022).

Despite their importance, the traditional jeepney system has been associated with significant challenges, including environmental concerns such as air pollution and greenhouse gas emissions. The reliance on aging, diesel-powered engines has made traditional jeepneys major contributors to urban air quality issues. In response to these challenges, the global shift toward sustainable transportation has highlighted electric vehicles (EVs) as viable alternatives. EV sales have surged globally, from over two million units in 2018 to a projected 56 million units by 2040, underscoring the urgent need for cleaner, greener transport solutions (BNEF, 2019).

In the Philippines, these global trends have catalyzed the government's Public Utility Vehicle (PUV) Modernization Program, which emphasizes the transition to eco-friendly vehicles such as electric jeepneys. This initiative aims to mitigate greenhouse gas emissions, reduce air pollution, and address fossil fuel dependency. By prioritizing technological advancements, the program seeks to provide commuters with safe, efficient, and environmentally sustainable transport options. Structured regulations and policies are central to this transition, ensuring that modernization efforts are responsive to the unique challenges of the Philippine transport landscape (Villegas et al., 2021).

IoT enables real-time monitoring, fleet optimization, and enhanced safety, improving operational efficiency and the commuting experience. Operators can access critical data on vehicle performance, passenger behavior, and traffic conditions, enabling better route planning and real-time adjustments.

In the rapidly evolving landscape of transportation, especially in regions like Nueva Vizcaya and Ifugao in the Philippines, the demand for innovative solutions addressing both environmental concerns and the efficiency of public transit systems is more pressing than ever. The introduction of modern public utility jeepneys (PUJs) is a pivotal advancement in achieving these goals, offering a sustainable and more efficient alternative to traditional fossil fuel-powered vehicles. However, integrating and managing these vehicles effectively within the existing transportation framework necessitates advanced technologies and robust management systems that cater to the unique needs of operators, drivers, and commuters.

In response to this challenge, the JEEP-PS project emerges as a groundbreaking initiative designed to revolutionize the management and operation of modern PUJs. Through its advanced tracking technology and user-centric web application, JEEP-PS aims to optimize the efficiency and sustainability of public transportation. By harnessing the capabilities of modern technology and fostering collaboration among diverse stakeholders, JEEP-PS endeavors to enhance the overall commuting experience for passengers in neighboring regions, ultimately contributing to a more sustainable and efficient urban transport ecosystem.

With this, JEEP-PS is a web application that features tracking of modern public utility jeepneys (PUJs), offering advanced tools for improving operations and passenger experience. This study aims to cater to the following users:

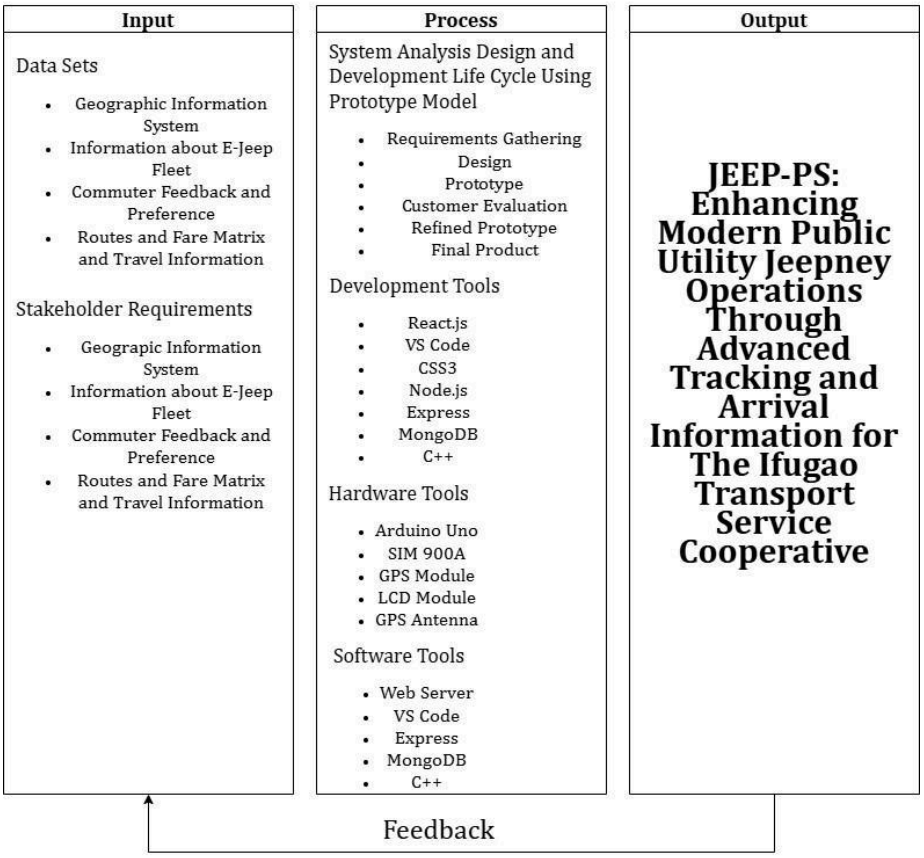
Operators. With the help of this system, operators can enhance the commuting experience, ensure adherence to service standards, and optimize fleet operations. The platform provides tools to monitor vehicle location, operational status, and seat availability.

Drivers. Through this system, drivers can receive real-time updates, enabling them to maintain reliable and efficient services. Features include seat availability indicators, vehicle condition notifications, and directional switches to indicate whether the PUJ is traveling northbound or southbound, streamlining operations and communication.

Commuters. With this system, commuters can track PUJ locations, access estimated arrival and departure times, and plan their trips effectively along routes from Lagawe, Ifugao, to Solano, Nueva Vizcaya.

Future Researchers. With this study, future researchers can use the insights provided as a reference to improve and innovate public transportation systems.

Figure 1
Conceptual Framework



Statement of the Problem

The proposed study aimed to develop the JEEP-PS, a web-application system for tracking modern PUJs and providing arrival information for Ifugao Transport Service Cooperative. Specifically, it sought to answer the following questions:

1. What are the problems encountered by modern PUJs operators in terms of:
    a. Tracking modern PUJs locations
    b. Monitoring seat availability and vehicle condition
    c. Updating commuters on routes, arrival, and departure times.
2. What are the problems encountered by modern PUJs commuters in terms of:
    a. Tracking modern PUJs locations
    b. Accessing arrival and departure information
3. What system will be developed to solve the problems encountered by modern PUJs operators and commuters in Nueva Vizcaya?
4. What is the extent of compliance of the proposed "JEEP-PS: Enhancing Modern Public Utility Jeepney Operations Through Advanced Tracking and

Arrival Information for The Ifugao Transport Service Cooperative" with ISO 25010:2015 Software Quality Standards as assessed by commuters, operators, and regulatory authorities in terms of:

d. functional suitability,
e. performance efficiency,
f. compatibility,
g. usability,
h. reliability,
i. security,
j. maintainability, and
k. portability?

METHODOLOGY

Research Design

This study employed a combination of descriptive and developmental research methodologies to ensure a comprehensive approach to both software and hardware development.

In the descriptive research design, data were gathered through interviews with PUJ operators and drivers, surveys distributed to commuters, and observations of transportation operations. These methods identified key issues, including route inefficiencies, wait times, and the lack of real-time tracking information.

For the developmental design, the prototyping model was adopted. The process included system requirements planning, prototype development, client feedback, and iterative refinements. For hardware development, an iterative approach was used, focusing on integrating and testing GPS and GSM modules to ensure reliable system performance.

Research Locale

The research was conducted along the route connecting Lagawe, Ifugao, and Solano, Nueva Vizcaya, key locations in Northern Luzon, Philippines. This route, served by the Ifugao Transport Service Cooperative (ITSC), is vital for regional transportation. Lagawe, the cooperative's headquarters, oversees planning, management, and operations, while Solano, a busy urban center, is a major destination for commuters and trade.

The Lagawe-Solano route served as the testing ground for "JEEP-PS: Enhancing Public Utility Jeepney Operations through Advanced Tracking and Arrival Information," leveraging ITSC's cooperation to improve efficiency and commuter experience. This collaboration highlights the potential for scalable, sustainable, and inclusive transportation solutions in similar regions.

Research Participants

The participants in this study were selected for their unique roles and insights into the operations and challenges surrounding modern PUJ services in the selected towns of Nueva Vizcaya. The participants included individuals directly involved in modern PUJ operations, commuters who utilize the service, and technical experts who contribute to system evaluation and development.

There were 15 participants divided into four categories: drivers, operators, commuters, and IT experts. Each group played a critical role in providing valuable data and feedback to ensure the system's relevance, usability, and efficiency.

Software Development

The adoption of the prototype model was a strategic approach to developing JEEP-PS, aimed at ensuring the system meets user requirements and operates effectively within its intended environment. This iterative process involved creating a working model or prototype of the system early in the development lifecycle. The prototype served as a tangible representation of the proposed solution, allowing stakeholders, including drivers, operators, and commuters, to provide feedback before full-scale development (Bennett, 2024).

The Prototype Model offers several advantages, including early identification of potential design flaws and an improved understanding of user expectations. By iteratively refining the prototype, the development team can address gaps, enhance system features, and ensure alignment with the objectives of the PUV Modernization Program. This method is particularly effective in projects like JEEP-PS, where user experience and system reliability are critical. (Lewis, 2023). Through continuous stakeholder interaction during the prototyping phase, the JEEP-PS project can integrate essential features such as real-time GPS tracking, user-friendly interfaces, and efficient communication modules. This approach not only minimizes the risks of system failure but also enhances user satisfaction by delivering a solution tailored to the unique needs of the Ifugao Transport Service Cooperative and its passengers.

Hardware Development

The iterative process model served as the foundation for hardware development in the JEEP-PS project, offering a structured yet flexible approach to managing the complexities of hardware design and prototyping. This model is particularly suitable for hardware development, where initial requirements are clear but additional functionalities or refinements emerge as the project progresses (Rana, 2023).

For JEEP-PS, this iterative approach enabled the development team to progressively integrate critical components, including GPS and GSM modules and microcontrollers. Early prototypes may focus on basic functionality, such as GPS tracking, while later iterations incorporate advanced features, such as GSM communication for real-time data transmission and emergency alerts. This step-by-step refinement ensures that the final hardware design is reliable, efficient, and capable of meeting the operational demands of modern public utility jeepneys.

By adopting the iterative process model, the JEEP-PS project minimized the risks of hardware failure and ensured the final system is optimized for durability and performance. This approach not only enhanced the overall quality of the hardware but also aligned with the project's goal of providing a sustainable and efficient solution tailored to the needs of the Ifugao Transport Service Cooperative and its passengers (Dumont, 2023).

RESULTS AND DISCUSSION

Section 1. Problems Encountered by Modern PUJs Operators

a. Tracking Modern PUJs locations

Operators face challenges tracking modern PUJs, relying on inefficient manual methods such as calls or texts, which lead to miscommunication and delays. Drivers often deviate from routes, such as extending Lagawe-Solano trips to nearby areas for personal gain, resulting in unaccounted revenue and operational inefficiencies.

b. Monitoring seat availability and vehicle condition

Operators face challenges in monitoring seat availability and vehicle condition. Overcrowding and inconsistent passenger counts complicate scheduling, while a real-time system could optimize dispatch and resource allocation by identifying peak and low-demand periods. Vehicle condition monitoring relies on manual driver reports, which are often delayed by signal issues or a lack of load, leading to breakdowns that disrupt operations.

c. Updating commuters on arrival and departure times

Providing timely updates is essential for commuters waiting in municipalities or locations distant from the terminal. These commuters often rely on estimating arrival times based on prior experiences, which can lead to inconvenience during delays. The absence of real-time communication hampers effective trip planning, especially during unexpected situations like heavy traffic, road closures, or bad weather.

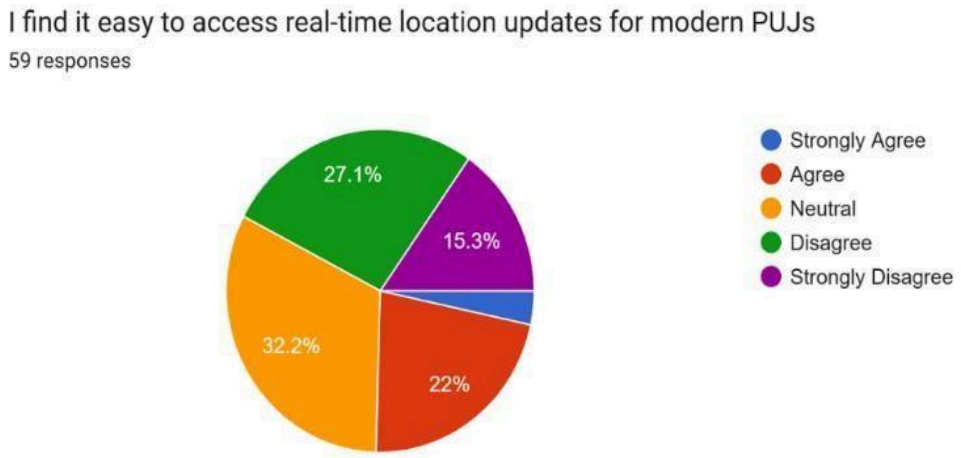
Section 2. Problems Encountered by Modern PUJ Commuters

a. Tracking modern PUJs locations

To understand the challenges faced by modern PUJ commuters in Lagawe, Ifugao, and Solano, Nueva Vizcaya, a survey of 59 respondents was conducted.

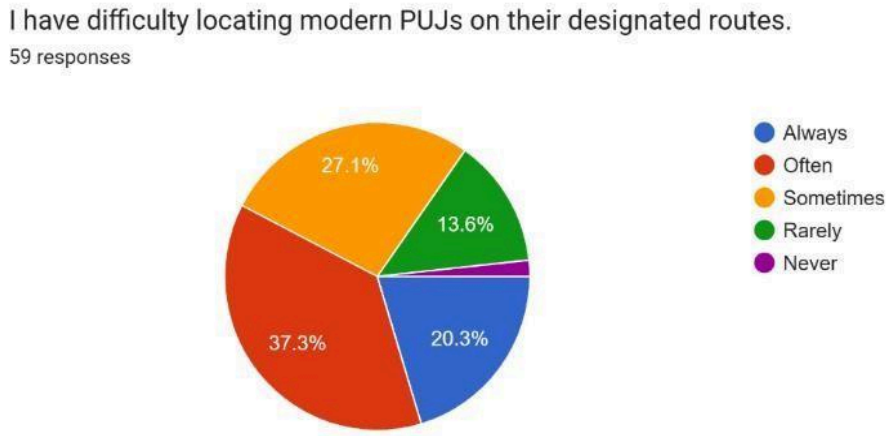
Figure 2

Commuters' Access to Modern PUJs Location Updates



The results in Figure 2 reveal that while 37.3% of respondents often find it easy to access real-time location updates for modern PUJs, a notable portion have difficulty doing so. Specifically, 27.1% sometimes face challenges, while 22% and 15.3% of respondents disagree or strongly disagree, respectively, that real-time location updates are easily accessible. These results suggest inconsistent access to reliable tracking information, which may disrupt travel plans, especially during peak hours. Improving the accuracy and accessibility of location updates through better GPS integration and user-friendly platforms could enhance the commuting experience and promote more efficient use of modern PUJs.

Figure 3
Commuters' Challenges in Locating Modern PUJs on their Routes



The results in Figure 3 reveal that while 37.3% of respondents often find a modern PUJ on their preferred routes, a notable portion experiences inconsistency. Specifically, 27.1% sometimes encounter modern PUJs, 13.6% rarely encounter them, and 1.7% never encounter them. On the other hand, only 20.3% of respondents always encounter a modern PUJ on their routes. These findings indicate gaps in service availability, which may disrupt travel plans, particularly during peak hours. Addressing these challenges through improved scheduling, optimized routes, and fleet expansion could enhance service reliability and provide more consistent access for all commuters.

b. Accessing arrival and departure information

The results reveal in Figure 4 that while 25.4% of respondents agree and 11.9% strongly agree that they can accurately predict modern PUJ arrival times, a notable portion faces challenge. Specifically, 37.3% remain neutral, while 20.3% disagree and 5.1% strongly disagree. These findings suggest a lack of schedule transparency and reliability, hindering efficient trip planning. Enhancing schedule accuracy through advanced scheduling systems and real-time IoT-enabled tracking could significantly improve commuters' ability to predict arrival times and enhance their overall travel experience.

The results in Figure 5 reveal that while 35.6% of respondents agree and only 3.4% strongly agree that modern PUJ schedules are accurate, a significant portion expresses uncertainty or dissatisfaction. Specifically, 37.3% are neutral, 18.6% disagree, and 5.1% strongly disagree. These figures highlight a lack of confidence in the current scheduling system. Addressing this issue by improving schedule precision and ensuring consistent adherence to published timetables is crucial. Such enhancements could rebuild trust, improve user satisfaction, and create a more dependable transportation system.

The results in Figure 6 reveal that while 22% of respondents agree and only 3.4% strongly agree that arrival time updates are reliable, a significant portion remains unconvinced. Specifically, 32.2% are neutral, and a combined 42.4% disagree or strongly disagree. This lack of confidence indicates a critical need for more dependable update systems. Implementing a robust real-time information system could enhance commuter trust and improve service reliability, encouraging more frequent usage of modern PUJs.

Figure 4

Commuters' Ability to Predict Modern PUJs Arrival Times

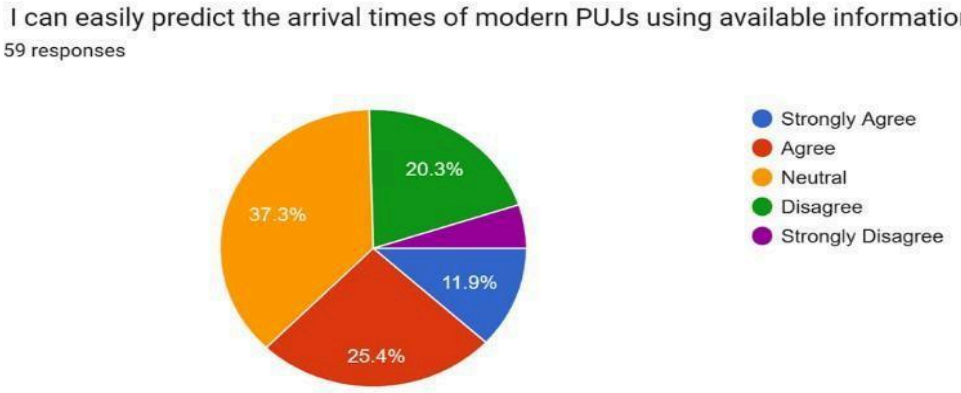


Figure 5

Commuters' Satisfaction with Modern PUJs Schedule Accuracy

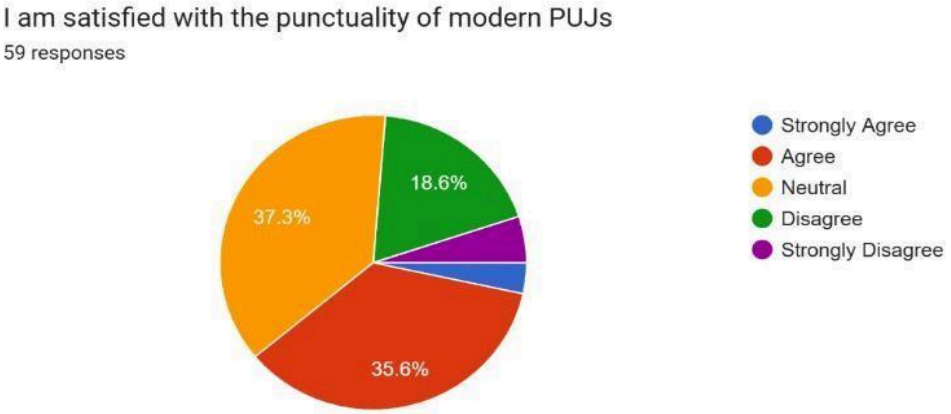
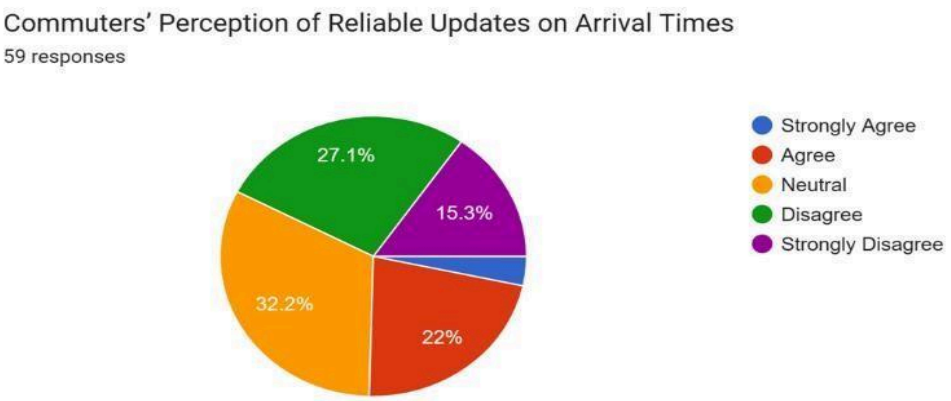


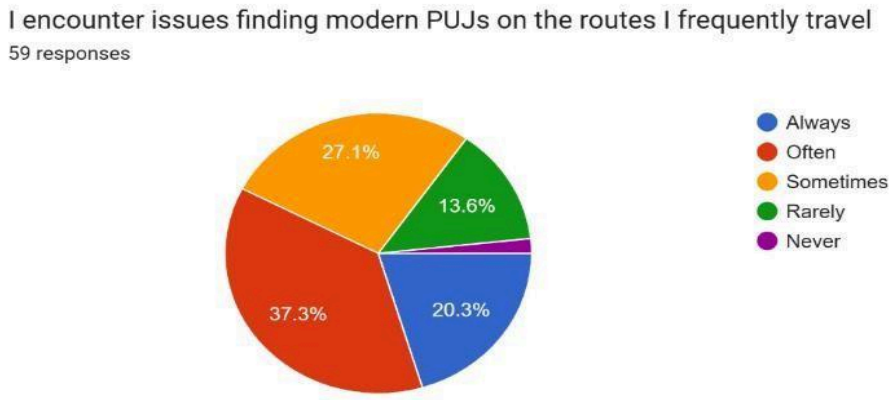
Figure 6

Commuters' Perception of Reliable Updates on Arrival Times



c. Navigating unoptimized routes

Figure 7
Commuters' Experiences with Modern PUJs Availability on Preferred Routes



The results in Figure 7 reveal that while 13.6% of respondents always and 37.3% often encounter challenges reaching their destinations on time, many still face issues due to unoptimized routes. Specifically, 23.7% sometimes experience these challenges, 20.3% rarely, and 5.1% never. These findings indicate that inefficient route planning significantly impacts travel efficiency. Addressing these challenges through dynamic route adjustments and real-time traffic data integration can enhance timeliness and improve overall commuter satisfaction.

Section 3. System Developed to Solve the Given Problems

The JEEP-PS: Pioneering Smart Mobility Solutions Through Advanced Modern PUJs Tracking Technology with Arrival Information in Selected Towns in Nueva Vizcaya was developed in collaboration with the Ifugao Transport Service Cooperative to address specific challenges faced by commuters and modern PUJ operators in the region. This system leverages advanced GPS and IoT technologies to provide near-real-time tracking of modern PUJs, aiming to improve commuting experiences and operational efficiency for both stakeholders and passengers.

By enhancing the visibility of the transport network, the JEEP-PS system reduces uncertainties surrounding modern PUJ arrival times, directly addressing concerns raised by commuters. Additionally, it empowers the Ifugao Transport Service Cooperative to better manage fleet operations, ensuring service reliability and adherence to schedules, which are critical to maintaining commuter trust and satisfaction.

The system's core features, such as near-real-time location tracking, allow both cooperative and commuters to access live updates on the positions of modern PUJs. This transparency helps commuters plan their journeys effectively while enabling the cooperative to monitor and optimize fleet performance. By providing accurate arrival information, JEEP-PS fosters confidence in the modern PUJs service and encourages more individuals to opt for public transport, contributing to reduced road congestion.

Seat availability monitoring, another critical component of JEEP-PS, ensures that commuters can make informed travel decisions based on the number of available seats in each

modern PUJ. This feature reduces overcrowding and improves passenger comfort. For the Ifugao Transport Service Cooperative, this data offers valuable insights into demand patterns, helping them adjust fleet allocation and schedules to better meet passenger needs.

JEEP-PS enhances operations by providing swift technical support and emergency response. In case of breakdowns or issues, the system promptly notifies the cooperative to dispatch assistance, ensuring passenger safety and reliable service.

Section 4. Extent of Compliance of JEEP-PS with ISO 25010:2015 Standards

Table 1
Functional Suitability

	Mean	Descriptive Equivalent	Interpretation
Functional Suitability			
Functional completeness	3.6	Compliant to a moderate to great extent	The measure described in the item is compliant to a moderate to GREAT EXTENT
Functional correctness	3.4	Compliant to a moderate extent	
Functional appropriateness	3.7	Compliant to a moderate to great extent	

Functional completeness measures the extent to which a system or software covers all specified tasks and user objectives. In this case, the rating of 3.6 suggests that the system is compliant to a moderate to great extent in terms of fulfilling all specified tasks and user objectives. This is a positive indication that the system is comprehensive in addressing user needs. Overall, these results indicate that the system performs well in terms of functional completeness, correctness, and appropriateness. While the ratings indicate that the system generally meets user needs and objectives, the moderate scores could be improved further to maximize satisfaction for all stakeholders.

Table 2
Performance Efficiency

	Mean	Descriptive Equivalent	Interpretation
Performance Efficiency			
Time behavior	3.7	Compliant to a moderate to great extent	The measure described in the item is compliant to a moderate to GREAT EXTENT
Resource utilization	3.8		
Capacity	3.8		

Table 2 provides an evaluation of the system's performance efficiency across three key dimensions: time behavior, resource utilization, and capacity. Each dimension was assessed using a scale ranging from 1 to 5, with 5 indicating compliance to a very great extent and 1 representing compliance to a very little extent. These assessments are complemented by specific remarks to provide deeper insight into the system's performance.

In summation, the table results highlight a system that performs well in terms of time behavior, resource utilization, and capacity. All ratings surpass the midpoint of the scale, indicating compliance to a moderate to great extent. These findings affirm the system's reliability, efficiency, and capability to meet performance-related requirements effectively.

Table 3
Compatibility

	Mean	Descriptive Equivalent	Interpretation
Compatibility			
Co-existence	3.8	Compliant to a moderate to great extent	The measure described in the item is compliant to a moderate to GREAT EXTENT
Interoperability	3.8		

The table presents an assessment of the system's compatibility, covering two critical dimensions: coexistence and interoperability. These dimensions were evaluated using a scale ranging from 1 to 5, where 5 indicates compliance to a very great extent, and 1 represents compliance to a very little extent. The associated remarks further elucidate the system's compatibility performance.

In summary, under the overarching theme of compatibility, the table results demonstrate a system that excels in both co-existence and interoperability. Ratings for both dimensions surpass the midpoint of the scale, indicating compliance to a moderate to great extent. These findings imply that the system can operate efficiently in shared environments and communicate effectively with other components or systems, fostering seamless interactions and data exchange.

Table 4
Usability

	Mean	Descriptive Equivalent	Interpretation
Usability			
Appropriateness recognizability	4.2		The measure described in the
Learnability	3.9		
Operability	3.8		

User error protection	3.5	Compliant to a moderate to great extent	item is compliant to a moderate to GREAT EXTENT
User interface aesthetics	3.8		
Accessibility	3.8		

The table presents an evaluation of the system's usability, which encompasses several critical dimensions: appropriateness, recognizability, learnability, operability, user error protection, user interface aesthetics, and accessibility. These dimensions were assessed on a scale from 1 to 5, where 5 indicates compliance to a very great extent, and 1 indicates compliance to a very little extent. The associated remarks offer valuable insights into the system's performance regarding usability.

In summary, the table results indicate a system that performs well across multiple dimensions. The consistently high ratings, all surpassing the midpoint of the scale, reflect compliance to a moderate to great extent. Furthermore, it accommodates a diverse user base and provides robust error protection.

Table 5
Reliability

	Mean	**Descriptive Equivalent**	**Interpretation**
Reliability			
Maturity	4.2	Compliant to a moderate to great extent	The measure described in the item is compliant to a moderate to GREAT EXTENT
Availability	4.0		
Fault Tolerance	3.4		
Recoverability	3.5		

The table presents an evaluation of the system's reliability across four key dimensions: maturity, availability, fault tolerance, and recoverability. These dimensions were assessed using a scale ranging from 1 to 5, where 5 represents compliance to a very great extent, and 1 indicates compliance to a very little extent. The associated remarks provide specific criteria for assessing reliability.

In summary, the table results highlight a system that performs well across multiple reliability dimensions. Two dimensions received ratings exceeding 4, indicating strong compliance, while the other two dimensions achieved ratings reflecting moderate compliance. This suggests that the system is reliable under normal operation, consistently available, resilient in the face of faults, and capable of effective data recovery.

Table 6
Security

	Mean	Descriptive Equivalent	Interpretation
Security			
Confidentiality	3.5	Compliant to a moderate to great extent	The measure described in the item is compliant to a moderate to GREAT EXTENT
Integrity	3.5		
Nonrepudiation	3.2		
Accountability	3.0		
Authenticity	3.2		

The table presents an evaluation of the system's security, encompassing five essential dimensions: confidentiality, integrity, non-repudiation, accountability, and authenticity. These dimensions were assessed using a scale ranging from 1 to 5, where 5 signifies compliance to a very great extent, and 1 indicates compliance to a very little extent. The associated remarks offer specific criteria for evaluating security.

In summary, the table results highlight a system that demonstrates strong security performance across multiple dimensions. While some dimensions achieved ratings indicating compliance to a great extent, others achieved moderate ratings, showcasing a well-rounded but improvable security framework.

Table 7
Maintainability

	Mean	Descriptive Equivalent	Interpretation
Maintainability			
Modularity	3.7	Compliant to a moderate to great extent	The measure described in the item is compliant to a moderate to GREAT EXTENT
Reusability	3.5		
Analyzability	3.2		
Modifiability	3.3		
Testability	3.2		

The table presents an evaluation of the system's maintainability, which comprises five essential dimensions: modularity, reusability, analyzability, modifiability, and testability. These dimensions were assessed using a scale ranging from 1 to 5, where 5 represents compliance to a

very great extent, and 1 indicates compliance to a very little extent. The associated remarks offer specific criteria for evaluating maintainability.

In summary, the table results indicate that the system achieves moderate performance in maintainability across the evaluated dimensions. These results suggest that while the system meets maintainability requirements to a reasonable extent, there is room for improvement to enhance its overall ease of maintenance and adaptability.

Table 8
Portability

	Mean	Descriptive Equivalent	Interpretation
Portability			
Adaptability	4.1	Compliant to a moderate to great extent	The measure described in the item is compliant to a moderate to GREAT EXTENT
Installability	3.3		
Replaceability	3.2		

The table provides an evaluation of the system's portability, encompassing three critical dimensions: adaptability, installability, and replaceability. These dimensions were assessed using a scale ranging from 1 to 5, where 5 represents compliance to a very great extent, and 1 indicates compliance to a very little extent. The associated remarks offer specific criteria for evaluating portability.

In summary, the table results show that the system performs well in terms of portability. These scores indicate that the system meets portability requirements to a moderate to great extent, with particular strengths in certain areas while leaving room for further optimization in others.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The study underscored the pressing need for technological innovation in modern PUJ operations, particularly in Lagawe, Ifugao, and Solano, Nueva Vizcaya.

Traditional methods for fleet tracking, communication, and maintenance management are insufficient to address the demands of a modernized transportation system. These inefficiencies hinder operators' ability to optimize services and lead to commuter dissatisfaction due to unreliable schedules and limited access to information.

The implementation of the JEEP-PS system is a transformative solution that addresses these critical pain points. Its advanced tracking capabilities ensure greater accountability and efficiency for operators, while features like seat monitoring and real-time updates enhance the commuter experience. The system not only resolves immediate challenges but also supports the broader goals of sustainable urban mobility by encouraging the adoption of modern PUJs and reducing transportation's environmental impact.

Through JEEP-PS, operators can gain insights into operational trends, proactively manage routes and maintenance, and build trust with their passengers. Commuters, in turn, benefit from a more reliable and user-friendly transit system. The success of JEEP-PS paves the way for the continued advancement of smart transportation solutions in Ifugao and Nueva Vizcaya, fostering a modern, commuter-centered ecosystem.

Recommendations

1. That future developers integrate a map feature for passengers to accurately track the position of the modern PUJs.
2. Future developers develop a mobile application for passengers to access the system easily.
3. Future developers integrate online payment for passengers to streamline their payment process, making it more convenient and efficient.
4. That local government units and transport cooperatives provide financial support and align policies to encourage the adoption of the JEEP-PS system.
5. That system developers continuously refine and expand the JEEP-PS system to include advanced features such as fare collection and dynamic route optimization.
6. That future developers develop a feature to detect the speeding limit for the admin to track the speed of the vehicle.
7. That future developers integrate customer feedback for passengers to enhance the user experience and improve service quality to better meet the needs and preferences of commuters.
8. That future developers integrate analytics for the cooperative to calculate how many passengers the jeep gets in a day, allowing for better route optimization and improved service planning.
9. That future developers will integrate notifications for sudden signal loss of the vehicle, ensuring that the cooperative is promptly informed of any tracking disruptions.

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