Lakbayan: Developing a Crowdsourced Public Transportation Mobile Application for the Philippines

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Abstract. Public transportation in the Philippines is multimodal and demand-responsive, yet commuters lack access to real-time, reliable route information. Existing navigation apps like Google Maps and Waze cater primarily to private vehicles, while local alternatives such as Sakay.ph and Moovit suffer from outdated or incomplete data. A promising approach is crowdsourcing, which gathers data directly from commuters to provide and validate route information. This study presents Lakbayan, a crowdsourced public transport app that enables users to submit and verify routes. It offers multimodal trip planning with landmarks and real-time updates through a live transit journal. In a limited deployment for user testing, users submitted over 100 trips, 60 journals, and 175 validation points. Validation methods were rated highly for usefulness and reliability. While data accuracy depends on continued user engagement, Lakbayan proves that commuter-driven tools can fill gaps by offering a participatory model for transport planning in the Philippine context.

Keywords: public transportation, crowdsourcing, software engineering

1 Introduction

Navigating the urban transport network of the Philippines requires commuters to transfer between various modes of transportation, including jeepneys, buses, UV Express, tricycles, and trains, to reach their destinations [14] [10]. Jeepneys typically carry 16 to 20 passengers in shared, open-air seating, offering affordable but often crowded and slow-moving rides that average around 20–25 km/h in city traffic. Tricycles, on the other hand, are small motorized vehicles that usually accommodate two to four passengers, operating over shorter distances at lower speeds and with limited comfort.

However, finding reliable, up-to-date route information remains a significant challenge. Commuters often rely on word-of-mouth navigation: asking drivers, locals, or fellow passengers for directions, which, while useful, is often inconsistent, outdated, or inaccurate [11] [8]. Existing navigation applications offer limited support: Google Maps and Waze cater primarily to private vehicles [15], while Sakay.ph and Moovit provide transit directions but lack frequent updates, real-time information, and support for unregulated modes such as tricycles [5].

J. Caro et al. (eds.), *Proceedings of the Workshop on Computation: Theory and Practice (WCTP 2025)*, Atlantis Highlights in Computer Sciences 24,
https://doi.org/10.2991/978-94-6239-638-8_32

One promising approach to address these information gaps is crowdsourcing, which has demonstrated effectiveness in tackling large-scale community-driven problems [8]. In developing cities where official infrastructure is limited or outdated, crowdsourcing has been shown to enhance the accessibility and accuracy of transportation data [9]. Public transportation apps such as Tiramisu and OneBusAway have successfully implemented crowdsourced data collection, allowing users to share information about routes, delays, and travel conditions [9]. By harnessing the collective knowledge of commuters, these systems enable faster dissemination of route information and improved navigation for daily commuters. Moovit, a global public transit app available in over 3,400 cities including Metro Manila, combines passive crowdsensing with active user input to bridge gaps in official transit data [6] [12]. However, Moovit's broad international focus limits its responsiveness to the localized and rapidly evolving conditions of Philippine public transportation, especially for informal modes and less-regulated modes like tricycles.

This highlights the lack of a dedicated, locally focused public transport route planner that effectively supports Filipino commuters in determining which public utility vehicles (PUVs) to take to commute from one point to another. The aforementioned systems are either not regularly updated or lack comprehensive coverage, leading to unreliable trip planning.

Recognizing this gap, this study explores the potential of a crowdsourced navigation system tailored to the complexities of Philippine commuting. To this end, it presents Lakbayan—a community-driven public transportation mobile application that enhances route discovery and real-time updates through active user participation. By leveraging crowdsourced data collection and validation, Lakbayan addresses the limitations of existing public transit navigation tools, providing commuters with up-to-date and accurate route information. Its participatory design approach ensures that users can contribute and verify data, allowing the system to adapt dynamically to real-time changes in transportation routes and conditions. Ultimately, Lakbayan seeks to improve the accuracy, accessibility, and reliability of public transport information, empowering commuters with verified, real-time insights that reflect the evolving nature of urban mobility in the Philippines.

The following sections of this paper present the design and implementation of Lakbayan, along with an in-depth discussion of its key features, how they address the current limitations in public transport navigation tools, and how they enhance the overall Filipino commuter experience. Preliminary evaluation results are also discussed, along with proposed directions for Lakbayan's ongoing development.

2 Methodology

This section covers key aspects of the system, which is done through a discussion of its overview and implementation. The overview section outlines the system's

core functionalities and features and the implementation section details the architecture, tools, and processes used to build the system.

2.1 System Overview

Lakbayan is designed as a crowdsourced public transportation mobile application that enables users to contribute, validate, and access real-time commuter-submitted data. This section covers how different user roles act in the application, the methods used to validate commuter-submitted information, and the reward system designed to encourage participation. Additionally, the implementation details of route creation, trip planning, and transit journaling are discussed, highlighting how Lakbayan enables real-time, community-driven transport data sharing.

User roles and privileges. To ensure a self-validating, community-driven system, Lakbayan defines three user roles: commuters, contributors, and moderators. Commuters find, review, and journal trips; contributors submit trips; and moderators validate submissions and oversee data. By default, users act as both commuters and contributors. High-scoring contributors may be promoted to moderators.

Route Submission. Unlike transport applications that rely solely on static datasets, Lakbayan enables users to contribute detailed, context-aware routes—such as custom trips and tricycle stops—through an interactive map-based interface.

For custom trips, contributors begin by specifying the start and end points of their trip. Each segment is then incrementally added by selecting the corresponding transport mode (e.g., jeepney, UV express, bus, train, tricycle, walking). An external map API suggests an optimal walking or driving path, which users can customize by adding waypoints, naming the route, and marking key landmarks (Figure 1). Submissions are then finalized after review.

For tricycle stops, contributors drop a pin on the terminal's location and add key details such as nearby landmarks or the terminal's assigned color. This lightweight process ensures submissions remain informative and useful for other commuters.

Validation System. Unlike traditional route-planning apps that rely on static or official transport data, Lakbayan leverages commuter-submitted information, which can be dynamic, incomplete, or inconsistent. To ensure data reliability, a comprehensive peer validation system is implemented, drawing on established best practices in crowdsourced data quality assurance [8] [1]. The system employs three key validation methods:

1. **Moderator Verification.** Inspired by peer-moderated platforms [4], experienced users serve as moderators who manually review and verify submitted routes. Verified entries display a check icon and a count of moderator approvals (Figure 2).

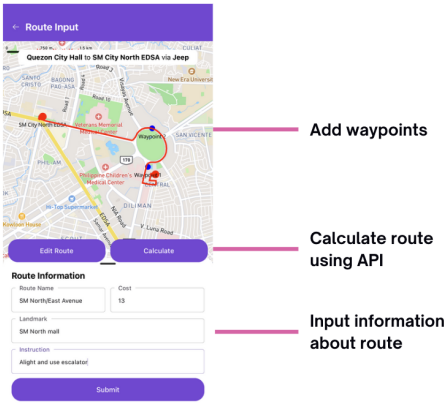

Fig. 1. Route input with waypoints and other details

2. **GPS Verification.** To counter fabricated or outdated submissions, Lakbayan compares user-submitted trips against GPS traces from transit journaling (see Subsection 2.1). When a trip aligns with the GPS traces, it is marked as GPS verified. The number of users who independently validate the route via GPS is shown with a location icon, reinforcing trust through passive data collection, as seen in platforms like Moovit [6].
3. **Community Validation through Upvotes and Downvotes.** Users can upvote or downvote routes based on their commuting experience, a mechanism that reflects majority consensus [2] [13]. High upvote counts signal reliability, while comments enrich the data with qualitative insights. Vote and comment counts also indicate community engagement (Figure 2).

Users who validate the submissions of other users can gain points, which can be used to avail rewards.

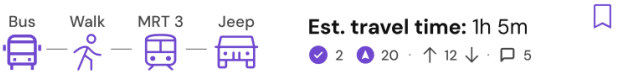

Fig. 2. Trip details with validation points (lower right)

Multimodal Trip Planning. Commuting in the Philippines often involves multiple transfers, and Lakbayan supports multimodal trip planning by recommending routes that combine jeepneys, UV express, buses, trains, tricycles, and walking. Commuters can search for routes by entering start and end locations,

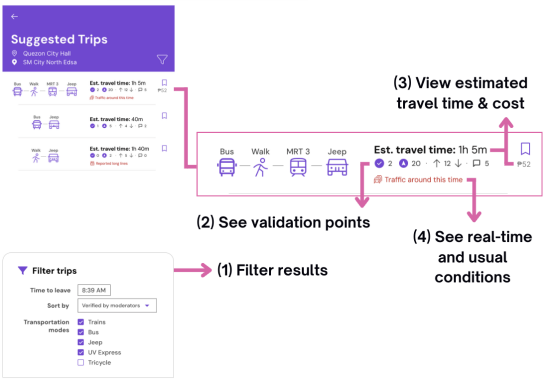

Fig. 3. Recommended routes with summaries and filtering options

and Lakbayan provides options (see Figures 3 and 4). While searching, commuters can:

1. **Filter results.** Customize trips by departure time, number of verifications, preferred transport modes, and exclusions (e.g., avoiding high-cost modes or minimizing walking).
2. **See validation points.** Community votes, comments, and verifications assess route accuracy and reliability, especially for informal routes.
3. **View estimated travel time & cost.** Helps commuters plan based on duration and fare (if available).
4. **See real-time and usual conditions.** Provides insights into traffic, queues, and delays based on users' transit journals, which will be discussed in the next section. Real-time data helps commuters anticipate disruptions and adjust their trips.

Upon selecting a trip, a detailed route view is shown (Figure 4) with features to support commuter decision-making. It includes a map, transit modes, estimated times, and landmarks. Users can bookmark and receive real-time updates via transit journals. A comments section allows sharing of route insights like bus intervals and queue lengths.

Real-Time Transit Journaling. Transit journaling is a crowdsourcing method where commuters log trip details—routes, times, transfers, and traffic—offering granular data that enhances route recommendations and validates conditions, especially where official data is lacking [3]. Similar to check-ins on platforms like Foursquare, it provides continuous, contextual updates.

In Lakbayan, the transit journal offers a live commuter view during transit, addressing the lack of real-time updates by using commuter-submitted GPS data. Key features include:

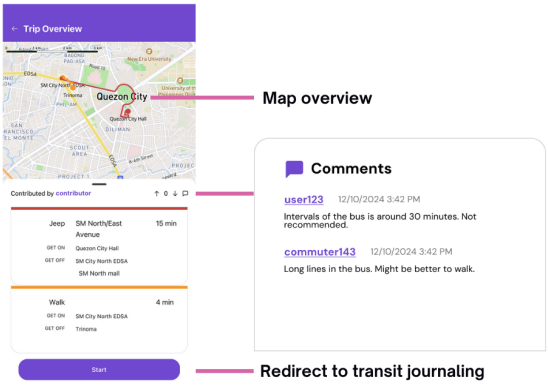

Fig. 4. Detailed route view

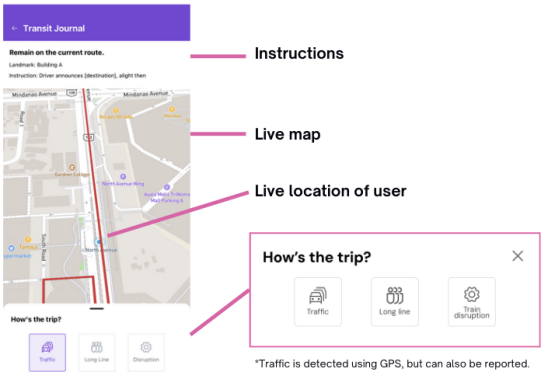

Fig. 5. Live view during transit journaling

- **Live GPS Tracking.** Lakbayan logs each commute in real time, which contributes to route validation (Figure 5).
- **Incident Reporting.** Commuters can report real-time conditions such as traffic, delays, and changes, which helps the system stay up-to-date and adapt to changing transit conditions.
- **Route Validation.** After a trip, commuters confirms the trip's accuracy; GPS-verified trips boost route reliability.

This feature empowers commuters to play an active role in maintaining accurate, real-time transit data for the broader commuting community.

Reward System To encourage user participation and ensure data quality, Lakbayan uses a point-based reward system grounded in gamification. Reputation-based strategies like karma points and incentivized voting have been effective in sustaining engagement and reliability in crowdsourced platforms [7] [14] [1].

The reward system includes the following components:

- **Karma Points.** Users accumulate points through user activities:
  - +1 per upvote
  - +3 per comment
  - +3 per GPS verification received
  - +5 for verifying another user's trip
  - +10 for submitting a GPS-verified route
- **Monetary Incentives.** Users reaching certain point thresholds can redeem monetary rewards via their chosen online banking platform (amount to be set by the admin).
- **Moderator Promotion.** Users with 500 points qualify for moderator status, allowing them to verify trips.

This system encourages accurate contributions while fostering an active, self-sustaining commuter community.

2.2 System Implementation

Lakbayan follows a client-server model, with the mobile app communicating with a backend to process submissions, verify routes, and manage incentives. The frontend is built using React Native (Expo) for cross-platform support, while Supabase handles authentication and database management. GPS integration enables real-time tracking, and both Google Maps and Mapbox provide location and mapping services.

3 Results

To ensure Lakbayan meets its goal of providing accurate, user-validated transport data, a multi-phase evaluation plan is implemented. The system will be tested for functionality, usability, and user engagement through controlled testing, real-world usage, and behavioral analysis. Initial user testing will be limited to selected areas in Quezon City, with participants using Android smartphones and stable internet.

3.1 Functionality Testing

To evaluate whether Lakbayan functions as intended, a round of functionality testing was conducted, specifically through User Acceptance Testing (UAT). A total of seven testers from the Service Science and Software Engineering Laboratory (S3) of the University of the Philippines Diliman, including the two researchers, participated in the evaluation. Each tester was tasked with validating predefined use cases that reflected the core features of the system.

Out of 51 identified use cases, testers were able to accomplish an average of 47, resulting in a completion rate of approximately 92%. The high completion rate and successful validation of features suggest that Lakbayan is functionally sound and ready for deployment in its current state.

3.2 User Testing

To assess the performance and usability of Lakbayan under realistic commuting conditions, a field testing phase was conducted with a broader group of participants. A total of 30 testers from the University of the Philippines Diliman took part in the evaluation. Each participant completed both a profiling questionnaire and a feedback form to contextualize their usage and assess their overall experience with the system.

The tester group was primarily composed of active commuters, with only one non-commuter among the participants. On average, users reported commuting five times per week, with each trip taking approximately 50.4 minutes. This commuting frequency and trip duration provided a meaningful basis for testing the application in real-world scenarios.

During the field testing period, the system logged over 2,000 data points. These included route searches, route submissions, transit journal entries, and various user interactions. The results of this user testing phase are analyzed in the following sections, each corresponding to one of the application's core objectives. These include support for multimodal route planning, the ability to crowdsource route data, informing users of route conditions in real time, and evaluating additional factors that influenced user experience and system trust.

Objective 1: Support for Multimodal Route Planning. Lakbayan was designed to support multimodal route planning by providing detailed, step-by-step commuting directions that span various transportation modes. To evaluate this objective, both app usage data and user feedback were analyzed.

During the field testing phase, users submitted a total of 105 trips, composed of 289 distinct trip segments. This results in an average of 2.76 transfers per trip, which aligns closely with the project's multimodal design target of approximately 3 transfers per trip. This metric indicates that users engaged with multiple transport modes when using Lakbayan for navigation.

Participants were asked to rate various aspects of the application's functionality using a 5-point Likert scale. The following average scores were recorded:

- *"Using Lakbayan helped me find better commuting options by discovering new and/or more efficient routes"*: 3.87/5
- *"I felt that my contributions (routes, stops, updates) were valuable to other users"*: 4.00/5
- *"I was able to easily find the transport stops for my chosen routes"*: 4.375/5

These results suggest a generally positive reception toward Lakbayan.

Every submitted trip included at least one segment with an instruction or landmark, which is essential for guiding commuters through complex routes. The average rating across all submitted trips was 3.39 out of 5, indicating a moderate level of user satisfaction with the trip guidance provided.

Lakbayan supported six different transportation modes, with walking being the most common. Upon analyzing the submitted data, users often add walking segments in between transfers of different transportation modes, increasing the detail of their trip submissions.

The inclusion of landmarks in user-submitted routes significantly supports multimodal route planning by making directions more intuitive and context-aware. A majority of users referenced buildings and transport stops to describe segments of their commute, enabling clearer step-by-step navigation—particularly in areas where formal signage or route markings are limited. This use of hyperlocal reference points mirrors the way directions are exchanged in everyday Filipino contexts, reinforcing the system's cultural and geographic relevance. Examples include:

- "Near Super 8 or St. Joseph" (Building)
- "Katipunan Jeep Terminal" (Transport Stop)
- "UP Town Center 2nd Floor Entrance near CCF" (Signage)

The quality of user-submitted instructions was also examined. A substantial portion of contributions were categorized as detailed, indicating that users not only provided origin and destination points, but also included specific directions such as vehicle labels, estimated travel times, and behavioral cues from drivers (e.g., confirmation of arrival at a stop). This level of granularity enhances the usability of the platform, particularly in urban contexts where formal signage or consistent route markings may be lacking. Even shorter entries like "ride the jeep labeled litex" reflect localized commuting knowledge that, while brief, remains functionally relevant. There are more trips with instructions than those without, which is a good indicator of high detail in the submitted routes. Some notable examples of user-contributed instructions include:

- "Follow the road until its end. You should see the road to Ylanan Gym at its end." (Detailed)
- "Ride the jeep labeled Litex." (Basic)

Additionally, a total of 45 stops were submitted during the testing period, many of which were associated with local TODA (Tricycle Operators and Drivers' Association) terminals. This is shown in Figure 6.

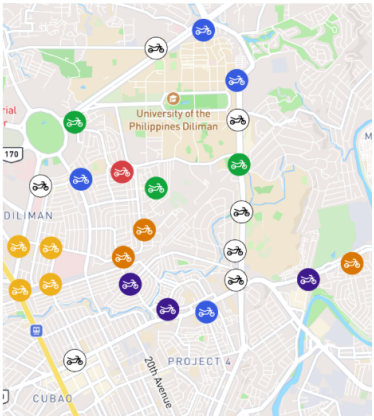

Fig. 6. Several TODA stops submitted in the app

Objective 2: Implements a community-driven verification system. To assess whether Lakbayan successfully implemented a community-driven verification system, multiple validation mechanisms were evaluated both in terms of perceived trust and actual usage. These included the voting system, moderator verification, GPS-based validation, and the comments section.

Voting System. The voting mechanism (upvotes/downvotes) ranked highly in terms of both perceived usefulness and trust. According to Figure 7, over 75% of respondents either agreed or strongly agreed that it improved their trust in crowdsourced data. In a separate analysis, it received a rating of 4.4/5, ranking second in verifying route reliability and third in improving trust. A total of 83 upvotes and 12 downvotes were recorded, with the highest-rated trip being from LRT 2 Katipunan Station to ISO Compound, Ateneo de Manila.

GPS Verification. GPS-based verification was the most trusted method, rated at 4.8/5. It was also the top contributor to route validation points, according to system data. As seen in Figure 7, it was rated highest both for improving trust and verifying trip reliability. Of the 64 recorded transit journals, 53 showed no deviation from the submitted route, further reinforcing the reliability of GPS-verified data.

Moderator Verification. Moderator-based review received high feedback as well, ranking second after GPS Verification despite the low amount of moderator reviews across all trips. This shows that users are more inclined to trust moderator reviews and it will be highly beneficial if more moderator input is added in the data.

Comments Section. Despite being the least trusted verification method, the comments section still provided value. With 80 recorded comments and a rating of 4.3/5, it allowed for nuanced corrections and suggestions. Common themes included route suggestions, confirmations, and error corrections.

Point Distribution. Verification efforts were also incentivized through a point system. Figure 8 shows that GPS-based methods (e.g., self-verification,

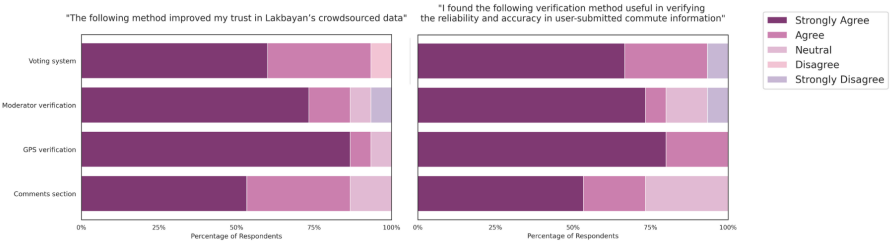

Fig. 7. Perceived usefulness and trust impact of each verification method

verification by others) were the top contributors to point accumulation, aligning with the system's emphasis on location-based credibility. Out of 30 users, the average number of points earned was 19.

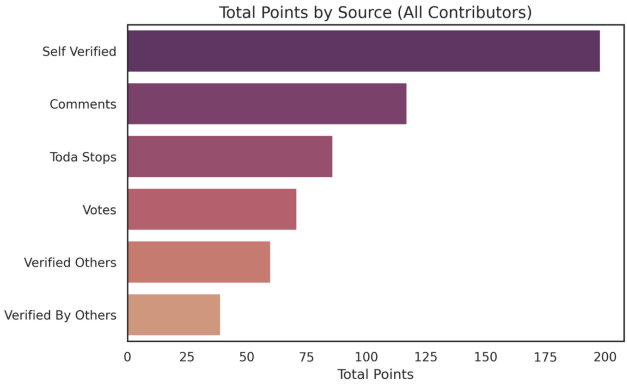

Fig. 8. Point distribution across all contributors by verification source

The collected data supports the claim that Lakbayan implements a robust, community-driven verification system. Among these, GPS verification emerged as the most trusted and reliable mechanism, both in user perception and actual consistency of route behavior. The high volume of upvotes and the strong rating for the voting system underscore the importance of socially visible validation in increasing data trustworthiness.

These results demonstrate that a layered verification approach can effectively build reliability in a community-moderated platform. The findings point to opportunities for further refinement, such as enhancing the structure of comment submissions to increase their perceived value.

Objective 3: Collates route options from other users using crowdsourcing. To evaluate Lakbayan's ability to crowdsource route options, user activity data was collected between May 4 and May 14, 2025. During this period, users submitted a total of 105 custom trips and 45 TODA stops, forming a substantial and diverse dataset of user-generated transport information. On average, each tester contributed around six submissions.

When asked to rate their level of data contribution, users responded with an average of 3.88 out of 5. This suggests that most testers found the process of contributing route data either easy, valuable, or worthwhile.

The effectiveness of these contributions is demonstrated in the application's trip search performance. Out of over 700 trip search logs, 91.5% successfully returned results, indicating that users were largely able to discover routes contributed by other commuters.

These findings suggest that Lakbayan achieved its third objective: collecting and surfacing route options through crowdsourcing. The high success rate of user searches, supported by meaningful user participation, indicates that the app's core mechanism—leveraging community-sourced transport data—was effective in enabling route discovery.

Objective 4: Informs users about route changes, conditions, and operational statuses based on crowdsourced information through transit journaling. Lakbayan aimed to inform users about route conditions and changes through transit journaling and real-time updates based on crowdsourced information.

During the testing period, a total of 84 transit journals were recorded. Of these, 60 were marked as completed, 16 as cancelled, and 5 were still ongoing at the time of data collection. These journals covered 56 unique trips, indicating that users tested the app on various real-world commutes both within and beyond the UP Diliman campus. Among the most frequently used routes were:

- 2s S. Salvador Street, Krus Na Ligas to 1101 Carlos P. Garcia Avenue, U.P. Campus
- 1101 Carlos P. Garcia Avenue, U.P. Campus to A. Maria Regidor Street, U.P. Campus

Beyond journaling, the application also supported live updates on transit conditions. A total of 11 live updates were submitted through the app during testing, covering events such as delays, traffic, and reroutes.

Feedback on these real-time updates yielded the following average ratings:

- Perceived accuracy of real-time updates: 4.19/5
- User reliance on real-time updates: 3.25/5
- Helpfulness of transport delay/change notifications: 3.5/5

These findings suggest that while users generally trusted the accuracy of updates, there is room to improve how these features are integrated into their commuting habits. Greater clarity in use cases or more compelling incentives

may enhance regular engagement with real-time reporting tools.

Overall, Lakbayan met its fourth objective by enabling transit journaling and facilitating real-time reporting of transit conditions, contributing to more informed and responsive commuting experiences.

3.3 Usability Testing

To evaluate user satisfaction and usability, the Standard Usability Scale (SUS) was administered to field testers. Lakbayan received a score of 81.4 out of 100, which is significantly higher than the industry average of 68. This corresponds to a Grade A rating, indicating excellent usability and suggesting that users would be highly likely to recommend the application.

Satisfaction. Testers rated Lakbayan's ease of use and the confidence they felt while using it at 4.31 out of 5. Reports of frustration were low, with the statement "unnecessarily complex" receiving a score of only 1.94 out of 5, and "very cumbersome to use" rated even lower at 1.56 out of 5. These scores suggest that the application was generally seen as smooth and straightforward to use.

Usability. The app's functionalities were perceived by users as well integrated, scoring 4.5 out of 5. Users also found the system easy to learn, giving it a rating of 4.37 out of 5. Additionally, dependence on technical support was minimal, with a score of just 1.62 out of 5 for the item concerning the need for tech support.

Overall, these findings indicate that users found Lakbayan to be intuitive, efficient, and user-friendly, with minimal barriers to adoption and a high level of satisfaction with its usability.

3.4 Domain Expert Validation

The domain expert validation was conducted with a domain expert from the National Center for Transportation Studies (NCTS) to assess the practicality, usability, and sustainability of the Lakbayan platform. The evaluation provided critical insights regarding the system's sufficiency, user engagement strategies, and data reliability.

Sufficiency. The expert affirmed that the system's current feature set is more than adequate to achieve its stated objectives. They commended the platform's simplicity and usability, highlighting its potential to be easily adopted by everyday commuters.

Engagement. The expert emphasized the potential of crowdsourcing as a viable long-term strategy for maintaining the platform. Drawing attention to the decline of similar platforms such as Sakay.ph, they advised implementing further simplification and automation of participation mechanisms to encourage continuous user contribution without disrupting the commuting experience.

Reliability. The expert acknowledged the limitations of GPS coverage in certain areas and endorsed the strategy of combining live GPS data with historical route information as a practical and effective means of enhancing data

accuracy and reliability. He also raised concerns about the dependability of the API intended for route suggestions, recommending that the system incorporate a mechanism to override API-generated routes when more contextually relevant data is provided by contributors. This approach would ensure that route recommendations remain grounded in actual commuter experiences.

4 Conclusion

Lakbayan was evaluated against four core objectives: multimodal route planning, community-driven verification, user-contributed data, and real-time journaling. Testing confirmed that the platform supports complex trips across six modes, with 105 trips and 289 segments submitted. Users discovered new routes and consistently included contextual instructions, showing Lakbayan's value as a commuter tool.

The app's validation features—votes, comments, GPS, and moderator review—were rated highly (4.5/5), with 175 validation points submitted. This shows strong user engagement in maintaining data reliability. Lakbayan also enabled community-sourced route building: 105 trips, 45 TODA stops, and 56 journaled trips were submitted, with 91% of route searches using user data. Finally, the platform captured 60 journals and 11 live updates, giving commuters timely, on-the-ground information.

Despite a small user base, Lakbayan amassed 423 data points. This affirms the viability of commuter-led transport planning when paired with layered, lightweight validation. Users particularly trusted GPS and voting features. While some uncertainty remains, the system boosts confidence in route data through participation.

Main Contribution. Lakbayan demonstrates how community-driven tools can support transport planning in cities with informal systems. It highlights that trust in crowdsourced data grows through transparent validation and shows what features matter most to commuters such as GPS-based checks and route discoverability.

Recommendations. To improve usability and accuracy, Lakbayan should support mid-journey edits, route deletion, offline mode, and auto-filled jeepney segments. Adding features that maintain core functions in areas with weak connectivity can make the app more dependable in real-world conditions. More flexible mapping and granular voting can refine trip data. Broadening the testing scope to include more varied routes throughout Metro Manila and a diverse user base, combined with continued optimization of moderation systems, will strengthen user trust, adoption, and overall reliability.

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