Operational and User Benefits of Mobility Hub Standby in a Taxi-Based DRT: From Pilot to Implementation in Hazu District, Japan

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Abstract. Efficient mobility services are essential for sustaining rural communities with limited transportation options. In Hazu District, Nishio City, Japan, the taxi-based demand-responsive transport (DRT) service Ikomaicar faced inefficiencies due to paper-based user authentication and depot-based vehicle dispatch from outside the district. To address these issues, a pilot project launched in January 2025 introduced two interventions: digitalization of user authentication and trip records, and the deployment of a standby vehicle at a railway station in the district on weekdays. The pilot demonstrated meaningful improvements in operational performance. Dispatch times were substantially shorter than expected under depot-based operation, contributing to reduced user waiting times. Service usage also increased, as evidenced by growth in registrants and unique users compared with the previous year. However, the modest rise in total trip counts relative to unique users points to potential temporal saturation despite enhanced capacity. Digitalization further enabled timely data sharing and iterative coordination among the municipality and taxi operators, supporting a co-design approach to service planning. Following validation through the pilot, the municipality plans to implement it as an official public program starting in April 2026. Because both interventions were implemented simultaneously, their individual effects cannot be clearly isolated. Even so, the findings highlight the potential of combined operational and digital measures to strengthen rural DRT services.

Keywords: Demand-responsive transport, Taxi service, Public transport, Mobility hub, Social implementation

1 Introduction

1.1 Background

Designing public transportation networks requires a good understanding of both the characteristics of each transportation mode and the unique features of the local context. Effective design should leverage regional assets to create systems to meet functional efficiency and community needs.

Operational models play a critical role in this process. In addition to conventional fixed-route and fixed-schedule services, many regions have adopted Demand Responsive Transport (DRT) systems, which operate based on user requests. While DRT can sometimes lead to higher costs, some studies have shown that it can significantly reduce operational expenses, especially in suburban areas [1].

Evaluating DRT services involves multiple dimensions—environmental, service, political, and financial—each with its own set of performance indicators [2]. Service-related metrics encompass operational efficiency perspectives, including total driven time for all requests and waiting time per request. There is a wide variety of dispatching rules and operational configurations within DRT, and various academic studies and practical implementations have evaluated and classified these characteristics [3].

Taxi-based mobility services represent a form of DRT. Taxis operate from depot or company offices, which may not be ideally located for efficient service delivery. This can result in long deadhead trips and extended wait times for users. To address this issue, a pilot project in Nishio City, Aichi Prefecture, Japan, relocated vehicle standby positions from the taxi depot to within the service area, aiming to improve both operational efficiency and user convenience.

1.2 Project Overview and Objective

The project took place in the Hazu District of Nishio City, Aichi Prefecture, Japan. Although a railway line runs east to west through the district, public transportation options for feeder and intra-district trips remain limited. The only available service is Ikomaicar, a taxi-based mobility service provided by the local municipality.

Ikomaicar serves residents without age restrictions and allows travel within their designated district. Users can board and disembark at either their home or one of several pre-designated locations. Upon request, it provides direct services between the origin and destination using a taxi vehicle. The fare is 300 JPY per ride, with the municipality subsidizing the difference from the metered taxi fare. DRT encompasses several operational configurations. When classified by the flexibility of boarding/alighting locations and routing, DRT services can be categorized into route deviation, point deviation, demand-responsive connector, request stops, flexible-route segments, and zone route [4]. According to this classification, Ikomaicar can be characterized as a point deviation service in which users travel between predefined stops.

In the Hazu and Higashi-Hazu districts, collectively referred to as Hazu District in this paper, the number and type of designated boarding points vary slightly depending on the user's residence. In total, 28 locations are available in addition to users' homes. These include three railway stations, five banks and post offices, four commercial facilities, ten clinics, three public facilities, and three welfare facilities.

The Ikomaicar service in Hazu District faced two operational challenges. First, the administrative burden of invoice calculation between the municipality and the taxi company was significant. Previously, drivers used paper vouchers to record each trip, including the metered fare, passenger information, and the origin-destination pair. The administrative officer manually entered this data for aggregation and billing purposes, which was a time-consuming process.

The second issue was the waiting time due to the absence of a taxi office within the Hazu District. Reviews of performance evaluation metrics for DRT identify the difference between actual and desired delivery time, as well as the waiting time before pickup, as key factors repeatedly highlighted across the literature [5]. Vehicles had to be sent from neighbouring areas, resulting in longer wait times for users and increased operational costs for the provider. Notably, Ikomaicar operates on a real-time request basis via phone calls, rather than through reservations. To address these issues, the pilot project introduced two key improvements:

For the administrative challenge, the project implemented a QR-based digital authentication system called Digitachi. This system replaced paper vouchers with QR codes, which drivers scanned with their smartphones to verify users and log trip data in real time. This eliminated the need for manual data entry and significantly reduced the back-office workload.

To address the waiting time issue, the project introduced a standby operation, stationing one Ikomaicar vehicle at Higashi-Hazu Station during daytime hours on weekdays. The taxi operator received financial support from the project to enable this arrangement. This change aimed to shorten dispatch times and reduce deadhead mileage, thereby improving both user convenience and operational efficiency. Among various studies on dispatch algorithms for DRT, some have focused on improving operating costs and passenger experience by pre-identifying high-probability boarding and alighting locations. The pilot examined in this study adopts a conceptually similar approach in that a vehicle is pre-positioned within the service area. An important contribution of this research is that such a dispatch strategy was implemented continuously for more than one year, enabling an empirical evaluation [6]. The pilot has three phases:

1. From January 27 to March 31, 2025, with full weekday standby at the station.
2. From April 1 to July 31, 2025, continuing the same operation as phase 1.
3. Starting on August 1, 2025, the standby schedule was reduced to three days per week (Monday, Wednesday, and Friday) to enhance financial sustainability.

Following validation through Phases 1 to 3, the municipality plans to implement the components of this pilot as an official public program starting in April 2026. This study aims to verify the pilot's effectiveness from two key perspectives: the reduction in dispatch time due to vehicle standby and changes in service usage, including the number of registrants, trips, and unique users.

2 Methodology

2.1 Evaluating Dispatch Time Reduction

Neither the pre-pilot usage logs nor the records stored in Digitachi during the pilot included timestamps for when the taxi company received ride requests. To accurately measure dispatch time, we asked the taxi operator to record the timestamps from the launch of the pilot. The series of request timestamps logs is available from January 27 to March 7, including data for a total of 222 ride requests.

Since no comparable data exists for the pre-pilot period, we estimated dispatch durations by assuming that the taxi company dispatches vehicles from its depot after receiving users' requests. The evaluation of the impact of station-based standby introduces the difference between these estimated times and the actual dispatch times.

Of the 222, boarding-location coordinates are also available for 195. For each of them, we calculated the estimated travel time from the depot to the actual boarding location using the Navitime trip planner API. The arriving time for each calculation corresponds to the actual pickup time. By comparing these estimated dispatch times with the actual times, we assessed the time-saving effect of standby operation. To ensure statistical validity, we apply a t-test to the average of actual and estimated dispatch times. Section 3.1 explains the results.

2.2 Evaluating Impact on Service Usage

This study evaluates the pilot's impact on service usage from three perspectives: the number of registrants, trips, and unique users. To assess registration trends, we tracked the number of registrants during the pilot by counting them on the user database.

For the number of trips, we used the trip records stored in Digitachi, which include user IDs, trip origins and destinations, and timestamps. From this data, we calculated monthly totals for both the number of trips and the number of unique users. The analysis covered the period from February 2025 to January 2026 (one year after the pilot started), while the project itself remains active as of March 2026. To enable comparison with pre-pilot conditions, we used historical data from February 2023 to January 2025. This data, recorded initially on paper vouchers and later digitized by the municipality, contains the same fields, enabling comparison of monthly usage patterns.

Using both datasets, we examined changes in the number of trips and unique users before and during the pilot. To examine the changes associated with the pilot, we compare monthly usage during the pilot period (February 2025–January 2026) with the corresponding months in the previous year. In addition, to capture the underlying pre-pilot trend, we also collect usage data for the same months from two years prior. As described later, usage exhibited an upward trend both from the year preceding the pilot to the pilot period and from two years prior to the preceding year. We therefore conduct a one-sided paired t-test to statistically assess whether the pilot project further accelerated this pre-existing upward trend. Section 3.2 discusses the results.

3 Results

3.1 Reduction in Dispatch Time

As noted earlier, the pilot project recorded dispatch times for 222 ride requests, capturing the duration between the request phone call and the actual dispatch of the vehicle. To evaluate the effectiveness of station standby, we compared actual dispatch times with estimated dispatch durations from the taxi depot, using the methodology described in the previous section.

The average actual dispatch time during the pilot was 15.7 minutes, while the estimated dispatch time from the depot was 22.1 minutes (see **Table 1**), indicating a 6.4-minute reduction. A two-sided t-test under heteroscedasticity yields a p-value of 6.62×10^{-12}, far below 0.001, demonstrating a statistically significant difference in the mean. This finding confirms that the standby operation can meaningfully reduce user wait times and enhance service responsiveness.

Table 1. Time-saving effects for vehicle dispatching by standby operation at the station

Index	Actual waiting time	Estimated time from the depot
Number of samples	222	195
Min (min)	0	2.0
Max (min)	86	31.0
Average (min)	15.7	22.1
S.D. (min)	12.6	3.4

3.2 Impact on the Usage of Ikomaicar

At the start of the pilot, Ikomaicar had 341 registered users. By the end of Phase 1, the number had increased to 366; by the end of Phase 2, it had reached 397. As of the end of January 2026, during Phase 3, the total number of registrants stood at 424. This represents a 1.24-fold increase over the course of a year.

Table 2. The transition of the usage during the pilot and the same month of prior years

Month	Total number of trips (YOY)			Unique number of users (YOY)		
	During pilot	PY	P2Y	During pilot	PY	P2Y
Feb.	197 (+25)	172 (+24)	148	48 (+7)	41 (+4)	37
Mar.	276 (+90)	186 (+6)	180	55 (+11)	44 (+15)	29
Apr.	275 (+63)	212 (+30)	182	53 (+13)	40 (+5)	35
Mar.	239 (+31)	208 (-2)	210	52 (+10)	42 (+7)	35
Jun.	252 (+36)	216 (+25)	191	64 (+19)	45 (+7)	38
Jul.	257 (+14)	243 (+66)	177	57 (+15)	42 (+4)	38
Aug.	237 (+18)	219 (+49)	170	56 (+12)	44 (+7)	37
Sep.	219 (-19)	238 (+46)	192	49 (-2)	51 (+9)	42
Oct.	227 (-1)	228 (+41)	187	49 (+1)	48 (+14)	34
Nov.	241 (+60)	181 (+17)	164	50 (+6)	44 (+6)	38
Dec.	269 (+52)	217 (+58)	159	53 (+12)	41 (0)	41
Jan.	217 (+22)	195 (+52)	143	45 (+8)	37 (+3)	34

PY; Prior year (Feb. 2024 – Jan. 2025), P2Y; Two years prior (Feb. 2023 – Jan. 2024)

As for the total number of trips, between February 2025 and January 2026, we tracked monthly trip volumes to assess the pilot's impact on usage. Over the 12 months from the year preceding the pilot to the pilot period, trip volumes increased in 10 months compared with the corresponding months in the previous year, with an average monthly increase of 32.6 trips. The data from two years prior to the preceding year also show an upward trend: trip volumes increased in 11 of 12 months, with an average monthly increase of 34.3 trips (see **Table 2**). The one-sided paired t-test yields a p-value of 0.45, indicating that this difference is not statistically significant.

To determine whether a few frequent users received this benefit or more users did, we examined the number of unique users per month. An upward trend is observed both from two years prior to the preceding year and from the preceding year to the pilot year, with increases in eleven out of twelve months in both periods (see **Table 2**). The mean monthly increase was 6.8 users from two years prior to the preceding year and 9.3 users from the preceding year to the pilot year, indicating a stronger upward trend during the pilot year. The one-sided paired t-test yields a p-value of 0.15.

4 Discussion

During the pilot period, the number of registrants increased by 24% one year after the pilot began. This increase may reflect improvements in service convenience resulting from the digitalization of user authentication and vehicle standby operations, as well as heightened public awareness of the service through the pilot itself. However, it is difficult to identify which of these factors served as the primary driver.

Usage was already on an upward trend prior to the pilot and continued to grow during the pilot period. The pre-existing upward trend may reflect a recovery in travel demand after COVID-19, as well as rising demand for alternative options for private cars associated with population aging in the area.

Regarding the increase in the number of unique users, the t-test comparing the increase during the pilot with that of the previous year yields a p-value of 0.15, indicating no statistically significant difference. However, given the sample size, it is reasonable to state that the growth in unique users accelerated during the pilot period. Combined with the rise in the number of registrants, this suggests that the service became more widely recognized and utilized by residents. As with the increase in registrations, it remains difficult to determine whether the primary contributing factor was increased awareness, digitalization, or the standby operation.

The total number of trips also increased during the pilot period, surpassing the previous trend. This indicates that mobility provided by Ikomai-Car expanded and supported growth in travel demand. However, unlike the rise in unique users, the increase in total trips was similar in magnitude to the pre-existing trend. This suggests that system capacity may have sometimes approached saturation. As the dispatch times analysis indicates, operational efficiency improved due to the vehicle standby operation. Yet, because only one vehicle is assigned to the operation, the system may have reached its operational limit.

When one vehicle was placed on standby within the service area, the mean dispatch time was 15.7 minutes, which was significantly shorter than the time expected if vehicles were dispatched from the depot at the same time and to the same location.

This suggests that standby operation can enhance user convenience by reducing waiting times and improve operational efficiency by decreasing deadhead travel time.

The standby operation reduced dispatch time; however, it is important to note that this operation requires the operator to be compensated financially. To overcome this financial sustainability issue, the introduction of digital user authentication and trip records has contributed positively. By enabling the municipality (as the service provider) and the taxi company (as the operator) to quickly and easily monitor usage through a shared dashboard, the system facilitated discussions to design a more sustainable service model. Indeed, based on that, the number of standby operation days was reduced in Phase 3 without causing a substantial decline in usage. It is worth noting that the pilot not only improved service performance but also the service design process. Following validation through Phases 1 to 3, the municipality plans to implement the components of this pilot as an official public program starting in April 2026.

5 Conclusion

This study evaluated the effectiveness of a pilot project aimed at enhancing a taxi-based local mobility service in Hazu District, Nishio City, Japan. The project focused on two key interventions: the digitalization of user authentication and the introduction of vehicle standby within the district, starting in January 2025.

The observed dispatch times were significantly shorter than those expected of depot-based dispatch, indicating meaningful improvements in both user waiting times and operational efficiency. Although service usage had already been on an upward trend prior to the pilot, it was maintained or accelerated throughout the pilot period. In particular, the number of registrants and unique users increased, suggesting that the service became more widely recognized and used among residents. While total trip volumes also rose, the increase was less pronounced than that of unique users. This may indicate that the operation experienced temporal saturation, even though the standby operation increased the system's capacity. Overall, the pilot's digitalization measures and dispatch improvements can be interpreted as having generated positive effects on both operational efficiency and service utilization. At the same time, the findings suggest further improvements, such as addressing potential capacity saturation.

This study also faces several limitations. Because digitalization of user authentication and standby operation were introduced simultaneously, it is difficult to determine which intervention was the primary driver of increased usage. Moreover, the pilot itself might have contributed to expanding awareness of the service among local residents. Given that multiple measures were implemented concurrently, we note a limitation of this study: the inability to clearly isolate the key causal factor.

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