RESEARCH REPORT

Institute of Transportation Studies | UNIVERSITY OF CALIFORNIA

Partnering with Transportation Network Companies to Serve Low-Density Communities

Wesley Darling, Ph.D., Department of Civil & Environmental Engineering, University of California, Berkeley

Michael J. Cassidy, Ph.D., Department of Civil & Environmental Engineering, University of California, Berkeley

January 2026

UC Berkeley Institute of Transportation Studies

Report No.: UC-ITS-2024-03 | DOI: 10.7922/G20V8B5B

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
UC-ITS-2024-03	N/A	N/A

4. Title and Subtitle Partnering with Transportation Network Companies to Serve Low-Density Communities	**5. Report Date** January 2026 **6. Performing Organization Code** ITS Berkeley
7. Author(s) Wesley Darling, Ph.D., https://orcid.org/0000-0001-6757-9983 Michael J. Cassidy, Ph.D.	**8. Performing Organization Report No.** N/A
9. Performing Organization Name and Address Institute of Transportation Studies, Berkeley 109 McLaughlin Hall, MC1720 Berkeley, CA 94720-1720	**10. Work Unit No.** N/A **11. Contract or Grant No.** UC-ITS-2024-03
12. Sponsoring Agency Name and Address The University of California Institute of Transportation Studies www.ucits.org	**13. Type of Report and Period Covered** Final Report (August 2023 – August 2025) **14. Sponsoring Agency Code** UC ITS

15. Supplementary Notes
DOI:10.7922/G20V8B5B

16. Abstract
This study addresses the persistent challenge of delivering cost-effective, high-quality on-demand transit in low-density communities. Traditional microtransit services often struggle in such areas due to high fixed costs and limited opportunities to consolidate trips, while community partnerships with transportation network companies (TNCs) like Uber and Lyft are typically avoided due to concerns over data transparency and limited community control. To bridge this gap, we propose a new business plan for cooperative TNC partnerships, in which a community-appointed service manager coordinates trip requests, distributes financial incentives to attract drivers to the community from nearby high-demand areas, and leverages the TNC's existing digital infrastructure for driver dispatch and routing. We evaluate this business plan through case studies of three Northern California communities presently served by microtransit, comparing microtransit's measured performance against the predicted performance of a TNC operating under the proposed business plan using a simple metric that does not depend on the specific design of the transit system. Results show that TNCs can deliver higher levels of service and higher driver wages in all three communities and were more cost-effective than microtransit in two of the three. Applying the metric across California reveals that many communities with microtransit, and numerous other communities presently underserved by transit, would likely benefit from switching to TNC partnerships. This suggests that a large opportunity exists for using TNC partnerships to provide mobility in areas where other forms of transit are less effective.

17. Key Words	18. Distribution Statement
Demand responsive transportation, Public transit, Ridesourcing, Public private partnerships, Benefit cost analysis, Business models	No restrictions.

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	53	N/A

Form Dot F 1700.7 (8-72)

Reproduction of completed page authorized

About the UC Institute of Transportation Studies

The University of California Institute of Transportation Studies (UC ITS) is a network of faculty, research and administrative staff, and students dedicated to advancing the state of the art in transportation engineering, planning, and policy for the people of California. Established by the Legislature in 1947, ITS has branches at UC Berkeley, UC Davis, UC Irvine, and UCLA.

Acknowledgments

This study was made possible with funding received by the University of California Institute of Transportation Studies from the State of California through the Road Repair and Accountability Act of 2017 (Senate Bill 1). The authors would like to thank the State of California for its support of university-based research, and especially for the funding received for this project.

Disclaimer

Institute of Transportation Studies | UNIVERSITY OF CALIFORNIA

Partnering with Transportation Network Companies to Serve Low-Density Communities

Wesley Darling, Ph.D., Department of Civil & Environmental Engineering, University of California, Berkeley
Michael J. Cassidy, Ph.D., Department of Civil & Environmental Engineering, University of California, Berkeley

January 2026

UC Berkeley
Institute of
Transportation Studies

Report No.: UC-ITS-2024-03 | DOI: 10.7922/G20V8B5B

Table of Contents

Table of Contents

List of Tables

List of Figures

Executive Summary

Executive Summary

Suburban and exurban communities struggle to provide cost-effective public transportation. Traditional fixed-route buses tend to perform poorly in these low-density areas due to low rider demand, leading to high per-trip costs and low service frequency. Dial-a-ride services offer greater flexibility but often require advance booking and can result in long wait times. In response, many communities have turned to on-demand transit solutions, delivered either through microtransit providers like Via or through partnerships with transportation network companies (TNCs) such as Uber or Lyft. However, despite the fundamental differences between these service models, transit planning guides rarely clarify when a community would want to use one mode over the other.

Microtransit functions similarly to dial-a-ride, using a fixed fleet of vehicles and employee drivers to serve shared trips. The mode has high fixed costs and low variable costs, making it well-suited to settings where rider demand can be consolidated into shared vehicles. For its part, a TNC serves individual trips using a flexible, crowdsourced network of independent contractor drivers. Its cost structure is the opposite of microtransit: low fixed costs and high variable costs, with fares typically priced based on trip distance. Although TNCs offer greater flexibility and dynamic driver supply, many communities have avoided working with them due to concerns about limited data sharing, regulatory compliance, and service reliability. As a result, microtransit has become the default on-demand transit choice, even though it is often unsustainable in settings where demand is too low to efficiently consolidate trips.

This research addresses two pressing questions for communities seeking to improve their on-demand transit service: first, is there a business plan for partnerships that can induce TNCs to cooperate with low-density communities? Second, what characteristics make a community better suited to a TNC partnership than to microtransit? To answer these questions, we developed a new business plan for cooperative TNC partnerships, compared the plan's performance against real-world microtransit systems in three Northern California communities, and introduce a simple metric, which does not depend on the specific design of the transit system, that can guide communities in selecting the most suitable on-demand mode.

The proposed business plan employs a community-appointed service manager to coordinate all aspects of the on-demand service. This manager receives trip requests on its own custom smartphone application that it runs separately from the TNC's platform. This separation ensures the community maintains access to demand-related trip data and can implement its own local service policies through the service manager's app. After receiving trip requests, the service manager estimates each trip's regular TNC fare, then sets incentives for drivers (and a bonus for the TNC) and forwards the trip information to the TNC partner. The incentives are designed to attract drivers to serve trips in the low-density community by matching their expected earnings in nearby higher-demand areas. The bonus compensates the TNC for allowing its drivers to serve a lower demand area, which would otherwise be unprofitable. This extra compensation ensures ample driver availability and TNC cooperation, thus delivering a high level of service to the low-density community. Once the TNC accepts

the trip and compensation offers, it handles routing and dispatching drivers using its own algorithms, serving the request as usual.

Under this proposed partnership plan, each stakeholder (i.e., riders, drivers, the TNC, the community's local government, and the service manager) benefits in a way that leaves them at least as well off as under their next-best alternative. Riders compare the partnership to whichever transit option previously existed (e.g., microtransit, fixed-route bus, or no transit at all), while drivers and the TNC compare against serving trips in busier urban markets. The business plan guarantees stakeholders benefit by distributing subsidies and compensation offers. The local government subsidizes rider fares to cover most of the cost of service. Drivers earn a share of regular TNC fare revenue plus incentive payments from the service manager. The TNC receives fare revenue and the per-trip bonus. The service manager earns a per-trip commission from the local government. And, by working with a service manager, communities can maintain control over their on-demand service and its trip data while leveraging the TNC's flexibility and scale. Because at least one party benefits from switching to the partnership (e.g., riders receive a higher level of service for a low fare) without any being made worse off, the business plan is Pareto improving.

To evaluate the business plan in realistic settings, we compared the performance of existing microtransit systems in three Northern California communities (West Sacramento, Cupertino, and Rocklin/Loomis) to simulated TNC operations under the proposed plan. The simulation uses real trip request data provided by each community, along with community-specific estimates of TNC driver availability, vehicle speed distributions, and costs. The findings demonstrate that cooperative TNCs can offer substantial benefits, particularly in communities with low demand or small service areas where there is limited potential for trip consolidation. In Cupertino and Rocklin/Loomis, the simulated TNCs outperformed microtransit in both level of service and cost. In West Sacramento, where trip demand and consolidation are high, microtransit remained more cost-effective, though the TNCs still delivered higher levels of service and driver earnings.

The results of the case study comparison suggest that a community's ability to consolidate trips is the key determinant of which on-demand mode is most appropriate for that community. To quantify this, we propose a simple discriminating metric, ρ, defined as the result of multiplying a community's average trip demand by the average on-board travel time of a typical rider in that community. The value estimated for this metric is the number of new trip requests that arrive while a rider is en route to her destination, and it serves as a proxy measure of the community's potential to consolidate trips via microtransit. Higher values of ρ indicate that microtransit is likely to be more cost-effective (as there are more opportunities to consolidate trips), while lower values of ρ suggest that TNC partnerships may be the lower cost option. The metric was validated using case study data and used to identify a boundary value (ρ_b) where TNCs become more economical than microtransit.

Applying the metric to 46 California communities currently operating microtransit revealed that over half had metric values below the boundary, indicating that they might be better served by TNC partnerships. The metric was also extended to 154 California communities classified as underserved by public transit. Using a regression model that estimates the metric's value with population density and service area size as proxy variables, 78 of these communities were identified as strong candidates for TNC partnerships. These results highlight TNCs' potential for cost savings and improved service quality in a wide range of communities across the state.

In conclusion, this report provides a practical framework for rethinking how on-demand transit might be delivered in low-density communities. By offering a cooperative business plan that preserves community control and a simple yet discriminating metric to guide mode selection, this research equips planners and policymakers with actionable tools to make smarter decisions. With careful implementation, these strategies can help reduce public costs, improve levels of service, and expand equitable access to high-quality transportation in communities that have long been underserved.

Contents

Introduction

Suburban and exurban communities face persistent challenges in providing cost-effective public transportation. Traditional options like fixed-route buses and dial-a-ride services are often poorly suited to these low-density settings. Fixed route buses have high fixed costs and tend to be underutilized due to low, spatially dispersed rider demand. This results in high per-passenger trip costs and limited service coverage (*1*). While dial-a-ride systems offer greater flexibility in routing, they require advanced booking and often result in long wait times for riders (*2*, *3*). As a result, many low-density communities have turned to on-demand transit to expand their service coverage and improve rider convenience (*4*, *5*).

On-demand transit services allow riders to request trips through a smartphone or call center and receive curb-to-curb service, often within minutes thanks to dynamic routing. These services are typically provided either by microtransit providers, such as Via, or through partnerships with transportation network companies (TNCs), such as Uber or Lyft (*3*, *6*).

Microtransit, like dial-a-ride before it, provides pickup and drop-off service using a fixed fleet of community-owned vehicles operated by salaried drivers; and riders with similar origins and destinations are grouped (i.e., consolidated) into the same shared vehicles (*3*). (A key distinction is that microtransit serves on-demand trips typically requested through a smartphone app, whereas dial-a-ride usually requires advance reservations placed by telephone.) In low-density areas where demand is low and trips cannot be consolidated, microtransit pays drivers to circulate the service area even when vehicle utilization is low to stay available to serve infrequent trips. This distributes the community's capital and salary costs from operating the vehicles over few riders, resulting in high fixed costs per passenger-trip. Under these circumstances, microtransit's variable cost per passenger-trip is low, consisting primarily of fuel expenses for the duration of each rider's trip.

On the other hand, TNCs operate in low-density areas much like private taxis, serving individual trips with a crowdsourced fleet of independent contractor drivers.[1] When a community funds a TNC partnership, fixed costs are low because each TNC driver supplies her own vehicle and works only when trip requests arise (i.e., TNC drivers are not paid when not serving trips). This eliminates the need for capital investment or employee salaries (*4*). However, because the costs of vehicle use, driver labor, and access to the TNC's digital infrastructure are encompassed within a single, dynamically-priced fare, TNCs have a high variable cost per passenger-trip.

Although the two modes differ markedly in both service delivery and cost structure, few transit planning guides clarify when a community should use one mode over the other. Instead, mode selection is left to the discretion

[1] Some TNCs offer pooled or shared-ride options; however, many (e.g., Lyft) have largely discontinued these services or limit them to high-density urban areas during periods of high demand (*7*, *8*). Shared TNC rides would reduce the variable cost per trip by dividing the fare over multiple, simultaneous riders, though this is impractical in areas with low, sparse demand.

of the community itself (*6*). In practice, most communities opt for microtransit, largely due to concerns about working with TNCs that have historically resisted public input for service policies, withheld access to trip data, and have at times flouted local regulations (*9*, *10*). Rather than funding a service over which they have limited control, communities instead partner with microtransit providers, who share their data more freely and are more responsive to tailoring their service delivery according to local policies (*4*).

However, treating microtransit as a default solution has drawbacks. Due to microtransit's need to consolidate trips, it struggles to keep costs low in communities with very low demand. Because of the unsustainable costs, many microtransit pilot programs never last beyond the initial funding period. In many cases, paying for carefully crafted, individual TNC trips would have been cheaper.

Even so, using TNCs to provide on-demand service would require finding ways to obtain their cooperation with the community. This raises the two questions that have driven the present research:

1) Is there a business plan for TNC partnerships that can induce TNCs to cooperate with communities?
2) What characteristics make a community better suited to using a cooperative TNC partnership for on-demand transit versus contracting with a microtransit provider?

The findings in this report address these questions in the following way. First, a business plan for TNC partnerships is presented that centers around giving the community organizational control, transparency, and reliable on-demand service, while preserving the TNC's operational flexibility. Second, we simulate TNC operations under this plan in three Northern California communities used as case studies. Each community is currently served by microtransit, and we compare this service against the simulated TNCs. Third, we summarize the results of the case studies with a simple metric that communities can use to help decide in advance which mode (TNCs or microtransit) would likely be more effective given their characteristics. With these tools, we equip decision makers with the means to improve on-demand transit results, reduce costs, and better serve the residents of low-density communities.

Background

Transit agencies and local governments in low-density communities have pursued on-demand transit through partnerships with both microtransit providers and TNCs. Although TNCs were common partners in early pilot programs during the mid-2010s, communities have largely shifted toward microtransit, motivated by a desire for greater service control, data transparency, and service reliability (*11*). To systematically determine which mode is more appropriate for a given setting, researchers have developed quantitative planning tools. However, both the partnership structures and the planning tools currently suffer from important limitations. This section reviews the key lessons learned from past and proposed TNC partnerships and highlights the limitations of existing mode selection measures.

Past and Proposed TNC Partnerships

Early TNC-based partnerships were often structured as subsidized-fare programs, where transit agencies offered flat discounts or capped fares for trips within geofenced service areas (*4*, *12*). These arrangements were attractive because they required little upfront investment and were easily terminated, making them well-suited for short-term experiments. The TNCs typically filled the role of replacing low-demand bus routes, providing first-mile/last-mile access to transit stations, providing off-peak service, and as an alternative to ADA or dial-a-ride services.

Despite the initial promise, many of these pilot programs were discontinued once grant funding expired. Communities struggled with limited control over service provision, such as driver hiring practices or routing policies, and they often had little access into trip-level data due to the proprietary nature of TNC platforms (*13*). Moreover, service in low-density areas was inconsistent. TNC drivers, as independent contractors, are free to choose when and where they work. This leads drivers to congregate in high-demand areas and leaves smaller or more remote communities underserved (*14*).

These challenges notwithstanding, a few TNC partnerships have endured. The communities of Innisfil, Ontario, Canada and Monrovia, California continue to subsidize TNC service in lieu of traditional forms of public transit (*15*, *16*). These programs are popular and save costs when compared to fixed-route or dial-a-ride alternatives (*17*, *18*). However, both programs still face uneven driver availability and limited community oversight of service quality (*17*, *19*). These challenges illustrate the structural tensions that arise when local governments rely on privately controlled platforms.

In response, researchers have proposed new partnership arrangements intended to give communities greater leverage when working with TNCs. One such arrangement introduces a non-profit intermediary that serves as a liaison between the community and the TNC (*20*). The non-profit uses a customized interface on the TNC's app, helps manage rider bookings, and distributes fare subsidies. This partnership arrangement may also involve installing tablets or kiosks in community centers to support riders without smartphone or internet access. This approach is advantageous as the intermediary gains access to trip-level information by coordinating bookings with the TNC. Riders also benefit from the additional support and tailored subsidies.

However, this arrangement also carries significant limitations. Because the custom interface is built into the TNC's app, the non-profit intermediary remains dependent on the TNC's platform for dispatching riders and coordinating trips. This means the community still has no means of enforcing service policies or setting its own service standards. Additionally, all trip data are confined to the TNC's platform. Though the intermediary may be able to see real-time performance information, it does not have full transparency or after-the-fact access to the data collected. Finally, this partnership arrangement, which has a stated goal of improving transportation for underserved populations, does not address the fundamental problem of driver supply in low-demand areas. Thus, the level of service provided with this partnership is still vulnerable to changes in the TNC's service policies.

Another proposal recommends partnering with TNCs to provide first-mile/last-mile service to bus routes during low-demand periods or in sparsely populated areas (*21*). Segments of bus routes that are underutilized during such periods are truncated at transfer points. Riders pay a single fare and transfer seamlessly between the transit and TNC segments to complete their trips. To ensure ample driver coverage in the truncated areas, the proposal includes driver compensation schemes to make working in low-demand areas financially viable, otherwise drivers would likely not choose to work in these areas. With this mechanism in place, the partnership arrangement addresses the driver supply issue more directly than previous efforts and integrates private service into a broader transit network.

However, this partnership model falls short in other areas. TNC service is still accessed through the TNC's rider-facing app. This limits the transit agency's ability to monitor performance or enforce service policies. Because all aspects of service are handled on the TNC's platform, the agency also lacks control over supply-side operations (e.g., where and when drivers work) and remains vulnerable to unilateral TNC policy changes.

The two partnership proposals reflect growing awareness of the limitations inherent in current partnership structures. Each proposal introduces mechanisms to address a subset of concerns, but neither fully resolves the tension between public accountability and private platform control. In particular, both arrangements leave communities dependent on TNC infrastructure for core service functions and fall short of delivering operational control, data transparency, and service reliability in low-density areas.

Modeling On-Demand Transit Performance as a Function of Community Characteristics

Researchers have compared on-demand transit modes under different service conditions to identify the types of communities where TNCs or microtransit are most effective. The two classes of models used for this purpose are analytical models and agent-based simulation.

Analytical models often represent transit operations as simplified queueing systems (*22–24*). These models assume steady-state conditions and define queues corresponding to three vehicle states: idle, assigned (traveling to pick up a rider), and serving (traveling to drop off a rider) (*23*). Performance measures such as average rider wait time or on-board travel time are derived using Little's formula, and results are expressed as functions of demand, service area size, or fleet size.[2] While these models are useful for theoretical insight, they are not very practical as they typically rely on strong assumptions such as uniform demand distributions, constant vehicle speeds, and instantaneous matching of riders to vehicles (*26*, *27*).

To offer a more realistic alternative, researchers also use agent-based simulations (*28*). These emulate the movements of individual riders and drivers over space and time (*29*). They can incorporate detailed roadway networks, demand over different time periods, and stochastic (random) driver behavior (*30*). The models are commonly used to evaluate the performance of different service designs and operating policies under specified local conditions. However, they are computationally intensive and require fine-grained input data, which may not be available during planning stages.

Researchers use both types of models to generate "modal spectra," which are curves depicting optimal performance factors (such as cost) for distinct modes over a range of community types (*31*). For example, a spectrum might plot cost per trip for microtransit and TNCs as functions of demand density, service area size, or population (*24*, *32*, *33*). Composite measures, such as the product of demand per vehicle-hour and trip distance, have also been proposed (*21*, *34*). By analyzing the performance curves, one can identify a lower envelope which represents the lowest cost attainable by any mode for each value on the x-axis, i.e., a Pareto frontier. The boundaries between the curves along the Pareto frontier, at which one mode becomes more cost-effective than the other, can serve as decision criteria for planners (*23*).

However, existing community measures (including composites) have two important limitations. First, few directly account for a mode's ability to consolidate trips within a given community, even though this factor is central to the cost-effectiveness of microtransit (and transit in general). Measures that ignore this facet may underestimate the efficiency of transit in areas where trip consolidation is feasible. A composite measure proposed in Wright (*34*) comes closest, as it uses the product of demand and trip distance, which properly accounts for transit's ability to consolidate trips when demand is high and/or when trips are long.

The Wright measure falls short, however, as it suffers from the second, more important limitation: most existing measures rely on assumptions of how service is structured. In the case of the Wright measure, it measures demand by trips per vehicle-hour, making the resulting measure dependent on the fleet size, matching algorithms, etc. This makes it difficult to use the measure in the planning process before system design details have been established.

---

[2] Little's formula, $L=\lambda W$, relates the average number of items in a queueing system (L) to their arrival rate () and the average time they spend in the system (W) (*25*). Modeling a TNC operation as a steady-state queueing system implies that the required fleet size equals the average request rate multiplied by the average time each rider spends in the system from request to drop-off time. The latter is a function of the service area size, desired level of service, etc. (*23*).

While prior work has laid the foundation for comparing TNCs and microtransit, current tools fall short of what communities need. Existing partnership structures do not offer the community sufficient control over service policies or mechanisms for driver reliability, and existing community measures are too dependent on the specific design of the transit system to serve as reliable future planning aids. This report addresses both of these failings, by proposing a new, cooperative business plan for partnering with TNCs, and by introducing a simple, design-independent metric to guide mode selection.

Research Approach

A three-part approach was used to answer the research questions. First, we developed a business plan for cooperative TNC partnerships. We then evaluated this plan in three case study communities by comparing the measured performance of existing microtransit systems against the simulated performance of TNCs under the business plan. Key results from the comparisons are synthesized below into a simple metric, which distinguishes which mode best suits a community by relying only on aggregate service area data. This research approach is described in the following three subsections.

Business Plan for TNC Partnerships

The business plan described below addresses the shortcomings of prior arrangements between communities and TNCs. The proposed plan uses a community-appointed intermediary called the "service manager" to run all operations. The service manager balances the interests of all stakeholders, administers subsidies, and coordinates the delivery of on-demand services in the low-density community. Unlike past partnership arrangements where the TNC had control over all aspects of service delivery, this partnership maintains community authority while leveraging the TNC's existing infrastructure and driver network.

The proposed plan involves five key stakeholders. *Riders*, the users of the service, expect to receive high quality and accessible transportation service at fares comparable to those charged for other public transit modes (such as bus or microtransit). *Drivers*, who are the independent contractors that respond to trip requests, expect to earn wages on par with those available in nearby high-demand urban areas, and will only serve trips for the partnership if this expectation is met. The *TNC* supplies the technical infrastructure and driver network necessary for matching riders and drivers and efficiently routing trips. In exchange for giving up some control over local operations and for allowing its drivers to stay in a low-demand area (which would typically result in the TNC receiving less revenue), the TNC expects to be compensated. The community's *local government* serves as the partnership funder and primary public-sector authority. It expects the service to be reliable, equitable, and to come in under a budget. The *service manager* coordinates all other stakeholder interactions, oversees the flow of money and information through the system, and ensures that each stakeholder's expectations are met. In exchange, the service manager expects to be well compensated.

Each stakeholder will only participate in the plan if they stand to benefit at least as much as under their next-best alternative. Riders and the community's local government will compare the costs and level of service of the partnership to that of whichever transit option previously existed (e.g., microtransit, fixed-route bus, or no transit at all). The TNC and its drivers will compare serving trips for the partnership against continuing to serve trips in busier urban markets. Because the service manager is created for the business plan, it will participate in the partnership if it can profit from doing so.

The mechanisms of the proposed business plan proceed as follows. The service manager collects all trip requests through its own rider-facing smartphone application. By separating this operation from the TNC's platform, the local government can monitor performance, enforce service rules, and interact directly with riders (including gathering feedback with customer surveys) in real time. The service manager's app can also be accessed via call centers and physical kiosks to ensure inclusive accessibility.

After collecting trip requests, the service manager uses the TNC's application programming interface (API) to request an estimate for each trip's regular TNC fare. From the fare estimates, the service manager sets driver incentive prices that reflect trip distance, wages in nearby urban areas, and vehicle operating costs (e.g., gas and maintenance expenses incurred by the driver during the trip's expected duration). These incentives are designed to attract drivers to the service area by ensuring their expected wage remains competitive despite the low-density area's lower demand. The service manager also sets bonuses for the TNC so that it profits from cooperating and allowing its drivers to serve the low-density area. It is assumed that the incentive and bonus offers are set such that both drivers and the TNC find them profitable, and therefore always accept partnership trip requests. (The conclusion of this report discusses future research that could relax this assumption and employ dynamically adjusting incentives should acceptance rates fall.)

Following the compensation calculations, the service manager sends the trip requests and incentive/bonus offers to the TNC via its API. The TNC uses its proprietary matching algorithms to share the incentive offers and trip information with nearby available drivers. Once a driver accepts an offer, she serves the trip as normal and receives her compensation following the trip's completion.

The service manager coordinates the flows of money between stakeholders in a carefully structured manner. This is pictured in **Figure 1**. A rider pays a fixed government-subsidized fare (around the price of a bus fare) directly to the service manager (arrow 1). The service manager supplements this fare with public funding from the local government (arrow 2). This public funding is set to ensure that the full cost of the trip, including the driver incentive and bonus to the TNC, is covered (see box in figure). After the trip is completed, the TNC receives the regular TNC trip fare from the service manager (arrow 3) and an additional per-trip bonus for making its platform and drivers available (arrow 6). The driver receives her share of the regular TNC fare revenue through the TNC as usual (arrow 4), as well as the incentive for serving the on-demand trip, which is received directly from the service manager (arrow 5). The service manager is compensated by the local government with a per-trip commission for each trip request it fulfills (arrow 7). The value of this commission is set so that the service manager must fulfill all trip requests in order to receive a desired annual salary. Mathematical expressions for incentives and compensation are provided in Appendix A.

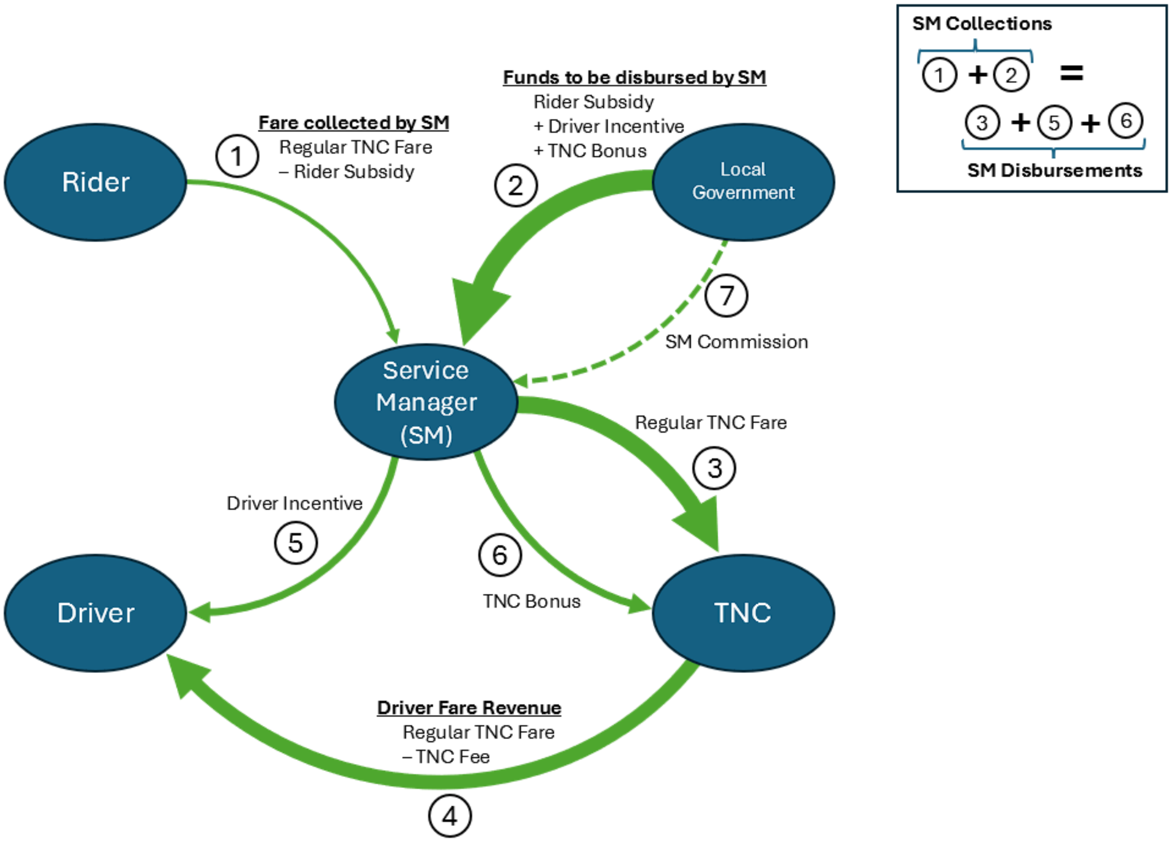


Figure 1. The flow of money per trip served in the proposed business plan.

The service manager coordinates information sharing among stakeholders in a similar manner, as pictured in **Figure 2**. Before any trips are served, the local government provides the service manager with policies and constraints, such as fare rules and geographic boundaries for the service area (arrow 1). A rider provides his trip origin and destination through the service manager's app (arrow 2). The service manager then shares this information (alongside incentive and bonus offers) with the TNC to facilitate trip matching and service delivery (arrow 3). The TNC shares the trip request and incentive information with available drivers (arrow 4) until one accepts the trip. Upon accepting the trip, the driver begins sharing her real-time location with the TNC as she travels towards the pickup location (arrow 5). The TNC sends the driver's information and expected time of arrival (ETA) at the pickup location to the service manager (arrow 6), which then relays the ETA to the rider. The rider's trip is served normally. Afterwards, trip records and performance data are stored by the service manager, allowing the local government to monitor service quality both in real time and over longer evaluation periods (arrow 8).

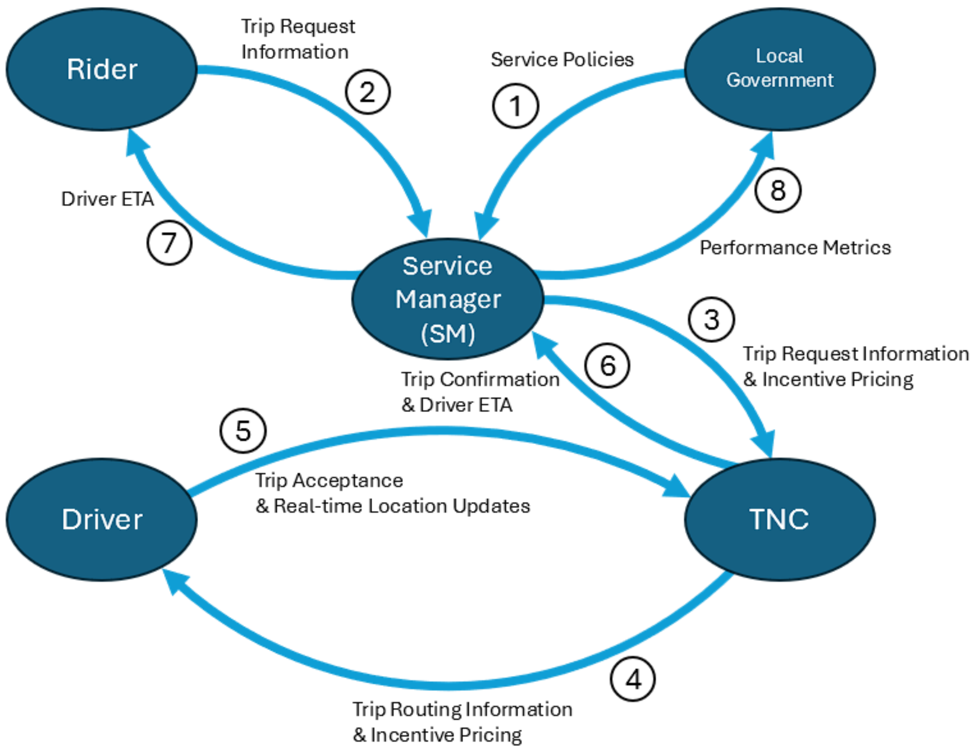


Figure 2. The flow of information per trip served in the proposed business plan.

The community is responsible for several key components of the plan. These include providing the service manager's smartphone application, establishing a call center, and strategically placing kiosks throughout the community. The smartphone app must support rider and driver accounts, secure payments, and interface with the TNC's API. The smartphone app should also allow for GPS tracking and real-time communication with all parties. The call center and kiosks ensure that riders without smartphones and internet access can still utilize the service, with all trip requests routed through the same backend system to maintain consistent performance monitoring.

The proposed business plan is arranged so that every participant does at least as well as they would under their next-best alternative, with some participants benefiting (such as the riders, who receive a higher level of service due to individually served trips). The partnership plan is thus Pareto improving, as at least one party is better off from participating without making anyone else worse off. The plan also allows communities to exercise local control over TNC operations to leverage the company's technology and scale of operations to provide high-quality on-demand transit service in low-demand areas. In this way, past concerns about TNC partnerships are addressed, in a cooperative, mutually-beneficial manner.

Case Studies of Microtransit and TNCs in Three Northern California Communities

To determine if the proposed TNC partnership can deliver comparable or superior on-demand service in low-density communities, the research team compared the performance of existing microtransit services to a simulation of cooperative TNC operations. Three Northern California communities that currently operate microtransit services were selected as case studies: West Sacramento, Cupertino, and Rocklin/Loomis. Each community reflects distinct service area characteristics. West Sacramento is an inner suburb of Sacramento with relatively high trip demand and a large service area. Cupertino is a city located in Silicon Valley with moderate trip demand and a small service area. Rocklin and Loomis are adjacent exurban communities northeast of Sacramento and together have a very large service area but very low trip demand. These communities' wide-ranging demand densities and operational contexts make them well-suited for our comparisons across modes.

The microtransit case studies draw on real-world trip request data, service contracts, and publicly available operating information obtained through public records requests (*35–39*). Key measures of performance include rider wait time, rider on-board travel time, consolidation (i.e., trip-sharing) rates, total and per-trip operating costs, and driver wages. The level of service measures (rider wait and on-board travel times) were calculated separately for shared and unshared trips to highlight the effect of consolidating trips.

As TNC operations under the proposed business plan do not yet exist, to evaluate the plan's potential performance in the case study communities, we developed an agent-based simulation that models how a cooperative TNC might operate under the same demand and geographic conditions as the existing microtransit systems. The simulation uses actual microtransit trip data as input; however, the simulation models driver supply and assignment decisions according to the logic of our proposed business plan.

The simulation model draws on several key inputs to mirror case study conditions as closely as possible. First, it incorporates the actual trip request patterns from each of the case study communities, using the same request times and pickup and drop off locations observed in the microtransit systems. Second, it estimates the baseline TNC driver supply using historical Uber data, which allows the model to represent the density and availability of drivers near each service area. Third, the model applies hourly speed distributions drawn from the microtransit data to assign realistic vehicle speeds at different times of the day throughout the simulation period. In addition, the simulation bases costs on community-specific parameters, including driver wages in nearby urban centers, TNC fare rates and platform fees, and per-kilometer fuel and maintenance expenses. Finally, the service manager's incentive prices are calculated using formulas that estimate a driver's distance to the pickup location since the service manager has only limited access to information about driver locations.

Comparing the performance of actual microtransit systems against that of simulated TNC partnerships enables a fair and controlled evaluation of levels of service and costs. By using identical trip demand and only varying operations and pricing, we isolate the implications of using cooperative TNCs in place of microtransit. The simulation model and parameters are described in greater detail in Appendix B.

Metric for Choosing Between On-Demand Modes

While simulation is a powerful tool for evaluating service designs, it is often too complex and time-consuming to use routinely, particularly if the details have not been finalized. To address this, the final phase of this study focused on using the results of the simulation to create a simple, design-independent metric to help planners decide (without simulation) whether microtransit or a TNC partnership is more appropriate given the community's characteristics.

The metric, denoted ρ, is based on two easily accessible community characteristics: trip demand (how many rides are requested per hour) and average on-board travel time (how long those rides take). The product of these two variables, which corresponds to the number of requests that arrive while a rider is en route to her destination, serves as a measure of a community's potential to group trips via microtransit. High trip consolidation potential favors microtransit, where economies of scale can significantly lower costs. In contrast, communities with low consolidation potential may be better served by TNC service. The metric's value at the boundary between the two regimes was determined by finding the Pareto frontier of the performance (cost) curves for microtransit and the simulated TNCs.

The metric was tested against the simulation model and then applied to California communities beyond the three case studies, namely, other communities that currently have microtransit, and communities that are currently underserved by public transit. A regression model was developed to estimate the metric in places that lack operational data. The model uses population density and service area size as proxy measures for trip demand and on-board travel time, respectively. This allows the metric to be applied at any scale, even in areas where transit service does not yet exist. Appendix C provides further information about the development of the metric and regression model.

Results

This section compares existing microtransit services and simulated TNCs for each of the three case study communities: West Sacramento, Cupertino, and Rocklin/Loomis. The key findings from these comparisons are then synthesized into a simple, discriminating metric that describes a community's potential to consolidate trips via microtransit. The metric is used to determine when TNCs become a more economical option than microtransit. The metric is then applied to numerous California communities to identify where TNC partnerships would likely improve on-demand transit.

Case Study Comparisons

Outcomes are evaluated in terms of both level of service and the monetary cost to the community. Expected earnings for drivers, the TNC, and the service manager are also duly considered.

Costs and earnings are presented as a range to capture low and high pricing scenarios. Because TNC fares are dynamically priced, contract terms with the TNC may vary, and the service manager's salary expectation is uncertain, each pricing scenario reflects a plausible best-case or worst-case outcome. Together, they provide an estimated interval representing pricing variability. Scenario parameters are based on observed real-world values (see Appendix B.1 for details).

West Sacramento

West Sacramento's microtransit system, operated by Via, serves approximately 445 trips per day. Over half of these (56%) were shared, or consolidated, trips thanks to the city's large service area and high demand. As shown in **Table 1**, consolidated trips resulted in longer rider wait and travel times, consistent with the detours required to pick up and drop off multiple passengers. In comparison, the simulated TNC partnership in West Sacramento offered improved levels of service, with average rider wait times 20% shorter across all trips. On-board travel times via TNC remained nearly identical, even though TNCs did not consolidate trips. It seems that West Sacramento's microtransit service prioritizes consolidating trips that minimally impact on-board riders. For example, a trip that adds very little distance to a vehicle's current route might be prioritized over earlier requests that require lengthy detours. This sort of operating policy would cause longer wait times but result in shorter on-board travel times.

Table 1. Level of Service Comparison – West Sacramento.

	Measured Microtransit			Simulated TNCs		
	All Trips	Consolidated Trips	Unconsolidated Trips	All Trips	Consolidated Trips	Unconsolidated Trips
Average rider wait time (minutes)	15.43	16.84	13.65	12.34	13.54	10.84
Average rider on-board travel time (minutes)	11.05	13.36	8.13	10.99	13.26	8.13

However, as shown in **Table 2**, the TNC partnership imposed significantly higher costs on West Sacramento's local government than the existing microtransit system due to the community's ability to consolidate trips. Thanks to the high demand and large service area, microtransit was able to achieve economies of scale to reduce its per-trip cost as demand increases. Conversely, the TNC's costs increase linearly with demand and the large service area worked against this, as TNC fares are largely distance-based. Although driver wages improved substantially under the TNC partnership, the increase in community costs meant that the TNC partnership would not be a Pareto improvement for West Sacramento.

Table 2. Cost and Earnings Comparison – West Sacramento.

	Measured Microtransit	Simulated TNCs
Average total daily cost	$8,207	$13,399–$17,968
Average cost per trip	$18.44	$30.11–$40.38
Average driver net hourly wage	$22	$39.22
Average TNC revenue per driver-hr	--	$23.83–$47.66
Average service manager commission per trip	--	$0.77–$1.54

Cupertino

In Cupertino, the Via-operated microtransit system averaged 112 trips per day with only 21% of trips consolidated. Short trip distances in the small service area made consolidation difficult and less effective. As shown in **Table 3**, consolidated trips again resulted in noticeably longer wait and on-board travel times for riders. The simulated TNC partnership in Cupertino substantially improved riders' levels of service, reducing wait and on-board travel times by approximately 17% and 18%, respectively. These were reduced across both consolidated and unconsolidated trips.

Table 3. Level of Service Comparison – Cupertino.

	Measured Microtransit			Simulated TNCs		
	All Trips	Consolidated Trips	Unconsolidated Trips	All Trips	Consolidated Trips	Unconsolidated Trips
Average rider wait time (minutes)	10.35	11.54	10.03	9.12	9.57	8.99
Average rider on-board travel time (minutes)	8.38	10.82	7.71	7.96	8.86	7.71

Table 4 shows that switching from microtransit to a TNC partnership would result in cost reductions ranging from 21% to 44%, depending on the pricing scenario, largely because of Cupertino's small service area. Its small size leads to shorter trip lengths, which makes it difficult for microtransit to consolidate trips. As a result, Cupertino pays for a (very expensive) microtransit service that tends to serve individual trips. In this instance, the short trip lengths make the TNC's distance-based fares low, rendering it the lower cost option. Drivers also benefit under the TNC partnership, earning 4% more than TNC drivers in the nearby urban area of San Jose, and more than double what drivers for Cupertino's microtransit system earn.

Table 4. Cost and Earnings Comparison – Cupertino.

	Measured Microtransit	Simulated TNCs
Average total daily cost	$5,555	$3,095–$4,388
Average cost per trip	$49.60	$27.63–$39.17
Average driver net hourly wage	$22	$44.63
Average TNC revenue per driver-hr	--	$28.76–$57.52
Average service manager commission per trip	--	$3.56–$7.12

The data indicate that a TNC partnership in Cupertino could make all stakeholders better off. This includes the local government, which would benefit from substantially lower costs. The key factor is Cupertino's small service area, which makes trips shorter and more difficult for microtransit to consolidate. Switching to a TNC partnership would be Pareto improving in Cupertino.

Rocklin/Loomis

Rocklin/Loomis had the lowest demand of the three case studies, with only 27 trips served per day. Despite the low demand, microtransit consolidated 36% of trips. This moderate consolidation rate was likely aided by the fact that Rocklin/Loomis' microtransit service allows trips to be booked on-demand or reserved in advance. Advanced notice gives the operators greater lead time to more optimally schedule and route trips. From a level of service comparison, however, the simulated TNCs still significantly improved rider wait times by approximately 17%. On-board travel time improvements were smaller, likely due to the reserved trips helping improve microtransit's routing. Results from the level of service comparison are presented in **Table 5**.

Table 5. Level of Service Comparison – Rocklin/Loomis.

	Measured Microtransit			Simulated TNCs		
	All Trips	Consolidated Trips	Unconsolidated Trips	All Trips	Consolidated Trips	Unconsolidated Trips
Average rider wait time (minutes)	23.78	26.14	22.16	21.72	22.38	21.28
Average rider on-board travel time (minutes)	17.87	21.68	15.25	17.20	20.04	15.25

The cost per trip under the simulated TNC partnership was relatively high. Three factors contribute to this. First, the large service area leads to longer trip distances, which increases TNC fares. Second, Rocklin/Loomis has the fewest number of available TNC drivers nearby, due to its distance from the nearest urban center (Sacramento). As a result, pick-up distances are greater, resulting in increased driver incentives and TNC bonuses. Third, because of Rocklin/Loomis' low demand, the service manager commission must also be very high (comprising 25–35% of the per-trip costs) to reach a desirable annual salary. That said, the TNC costs are still lower than those of microtransit, reducing the community's costs by 9–37%, depending on the pricing scenario. Other cost and earnings measures are presented in **Table 6**.

Table 6. Cost and Earnings Comparison – Rocklin/Loomis.

	Measured Microtransit	Simulated TNCs
Average total daily cost	$2,527	$1,585–$2,304
Average cost per trip	$93.36	$58.70–$85.33
Average driver net hourly wage	$23.15	$39.94
Average TNC revenue per driver-hour	--	$18.16–$36.32
Average service manager commission per trip	--	$14.80–$29.60

Switching from microtransit to a TNC partnership in Rocklin/Loomis would leave stakeholders better off, though a high pricing scenario would only lower the local government's costs by 9%. Riders would receive a better level of service and drivers would earn nearly double what microtransit drivers earn (and 2% more than what TNC drivers in Sacramento earn). Hence, switching from microtransit to a TNC partnership would be a Pareto-improving decision for Rocklin/Loomis.

Planning Metric

A key outcome of this study is the formulation and application of a simple, design-independent metric to help planners determine whether a community would be better served by microtransit or a TNC partnership. The metric, denoted ρ, describes the number of new trip requests that arrive while a typical rider is on board a vehicle traveling to her destination. This metric is closely related to a community's potential for consolidation via microtransit. It is calculated as the product of the average rate of demand and the average rider on-board travel time. A higher value of ρ implies a community has a greater potential to consolidate trips, making microtransit more cost-effective. Conversely, low ρ values suggest a community has limited consolidation potential, favoring TNC partnerships.

Applying this metric to the three case study communities revealed a strong relationship between ρ and the average cost per trip for microtransit services. As shown in **Figure 3**, communities with higher values of ρ, such as West Sacramento, achieved substantially lower per-trip costs. In contrast, Cupertino and Rocklin/Loomis, with lower values of ρ, experienced higher costs due to limited trip consolidation. This finding confirms that ρ serves as a strong indicator of consolidation, and thus a community's suitability for microtransit.

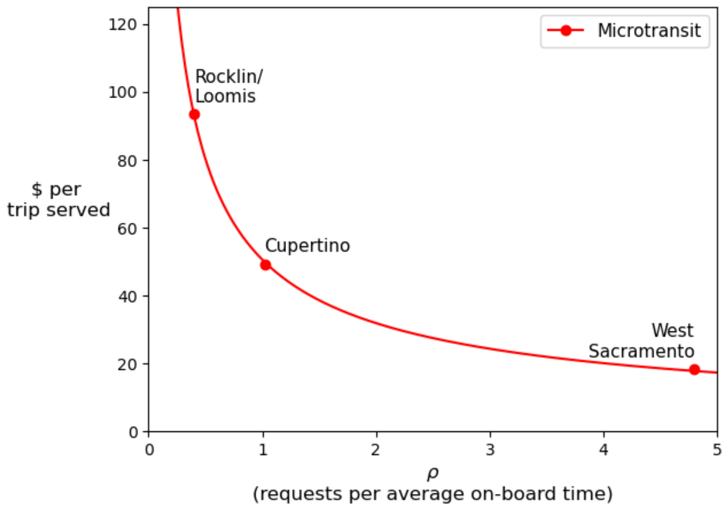
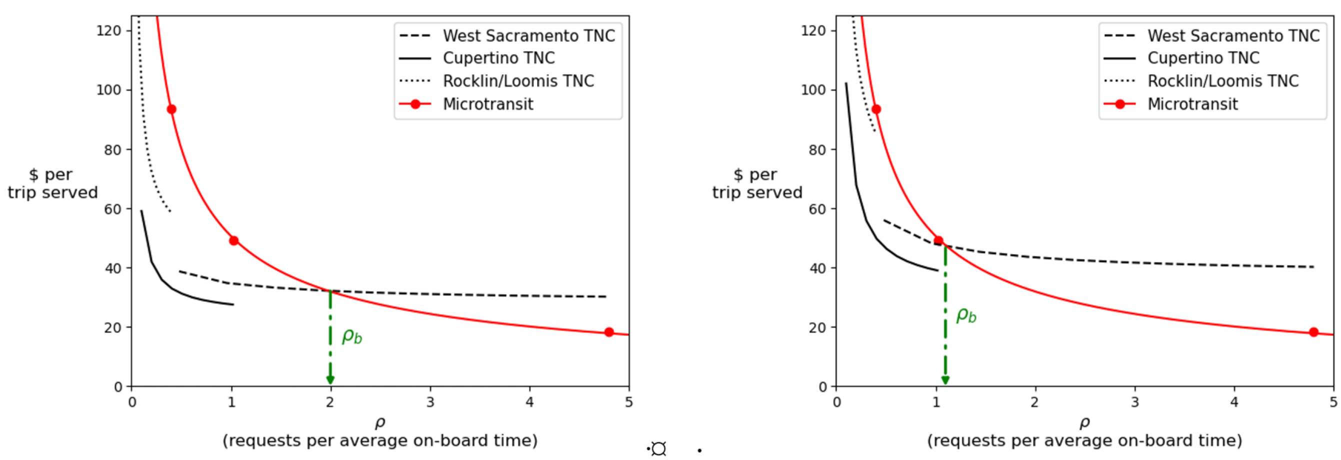


Figure 3. Microtransit performance curve (per-trip cost vs metric).

To establish a criterion for identifying low consolidation communities where TNC partnerships would work best, performance curves were generated by testing the simulated TNCs in each case study community under a range of demand levels (from 10% to 100% of actual demand). These curves are presented in **Figure 4** alongside the microtransit performance curve, with curves derived from simulations under a low pricing scenario presented in **Figure 4a** and those from a high pricing scenario presented in **Figure 4b**. The point where the performance curves intersect defines a boundary value of the metric, ρ_b, beyond which microtransit becomes the more cost-effective option. Under a low pricing scenario, this boundary value was identified as ρ_b = 2.0 requests per average on-board time, and under a low pricing scenario, ρ_b = 1.1 requests per average on-board time.



a. Low pricing scenario **b. High pricing scenario**

Figure 4. Performance curves for microtransit and simulated TNCs.

To identify where TNC partnerships could likely save communities money, the metric was applied to 46 California communities that currently have microtransit systems. For a conservative estimate, the high pricing scenario was assumed, making the cost-equivalence boundary $\rho_b = 1.1$ requests per average on-board time. Among the communities with microtransit, 24 had ρ values below the boundary, suggesting that TNC partnerships could deliver comparable (or better) service at a lower cost. These communities are indicated in **Figure 5** with a "T." These results highlight that nearly half of the microtransit systems currently in California may not be able to consolidate enough trips to be cost-effective.

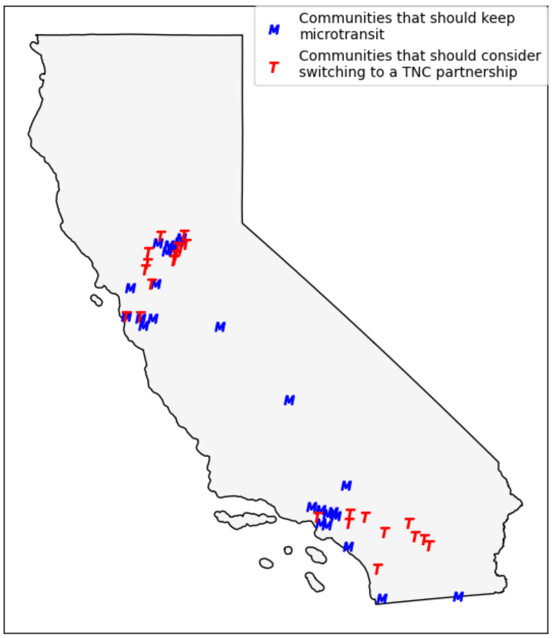


Figure 5. Locations of 46 communities with microtransit, including 24 that might be better served with TNC partnerships.

To extend this analysis and see the potential market for TNC partnerships, the metric was estimated for 154 California communities classified as currently underserved by public transit. Because detailed trip data were unavailable for these communities, the metric was estimated using population density and service area size as proxy variables. The resulting estimates showed that 78 of the 154 underserved communities had predicted ρ values below the boundary and thus would likely find TNC partnerships more economical than microtransit. The 78 communities are indicated in **Figure 6** with a "T." Importantly, this result does not imply that TNC service would be inexpensive or universally affordable for all of these communities, but rather that it would be more economical than microtransit.

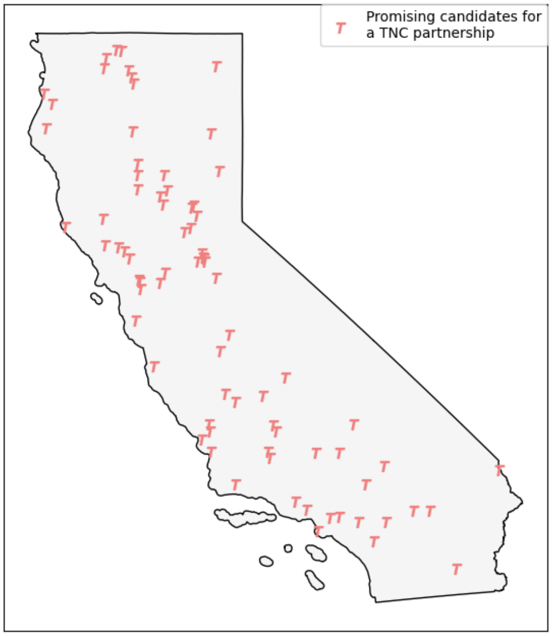


Figure 6. Locations of 78 underserved communities that are suitable for partnering with a TNC.

Discussion and Conclusion

This study offers new insights into how low-density communities can more effectively design TNC partnerships and evaluate on-demand transit service by comparing microtransit systems against cooperative TNCs. Through the crafting of a new business plan for cooperative TNC partnerships, case study comparisons against present-day microtransit services, and the formulation of a metric for evaluating cost effectiveness, the present research can help low-density communities better plan their on-demand transportation services.

Discussion of Results

The study reveals that a carefully-crafted partnership with a TNC can offer significant advantages over microtransit in many low-density communities, particularly those where low demand or short trip distances limit opportunities for consolidating trips. While microtransit has been the default choice for many low-density communities, it is not universally effective. Its cost-efficiency depends heavily on trip consolidation, which many communities cannot achieve due to low demand or small service areas. Communities have resisted partnering with TNCs in the past due to their lack of transparency and limited opportunities for community control. These shortcomings have motivated many low-density communities to choose microtransit, even when TNCs are likely to be the better option.

To address this concern, the present study introduced a new business plan for TNC partnerships that gives communities greater control over operations while ensuring that drivers and the TNC itself are suitably compensated for their cooperation. Central to this plan is a community-appointed service manager who collects trip requests through a custom smartphone application and sets and distributes financial incentives for drivers. In this way, the service manager can provide the community with greater access to trip-level data, operational control over local demand, and improved service.

This new partnership plan was evaluated under real-world conditions and compared against existing microtransit systems using an agent-based model. The model was created to simulate cooperative TNC operations in three Northern California communities: West Sacramento, Cupertino, and Rocklin/Loomis. The results of the case study comparisons showed that TNC partnerships consistently outperformed microtransit on level of service measures (e.g., rider wait time and on-board travel time) and were more cost-effective than microtransit in two of the three communities. In these two communities, partnerships were shown to be Pareto-improving: all parties (riders, drivers, the TNC, and the community's local government) would be at least as well off, if not better off, by switching to a TNC partnership. These findings point to a critical insight: trip consolidation is the key determinant of a community's most cost-efficient on-demand transportation mode. When consolidation potential is low, TNCs likely offer the community less costly service.

To support transit planning without the need for detailed analysis, the study also developed a simple, discriminatory metric, ρ, that expresses a community's consolidation potential and is comprised of just two variables describing a community's service area: average hourly trip demand and average on-board travel time. A regression-based version of the metric using widely available proxy variables (population density and service area size) was created to support its application in communities lacking current transit data. Using a performance curve analysis, the value of the metric at the boundary where TNC and microtransit costs are equal was identified for use as a decision criterion when planning on-demand services.

The metric was applied to 46 communities in California that currently operate microtransit. Outcomes suggest that over half of these communities might be better served by the proposed TNC partnership. When the metric was applied to 154 communities currently underserved by public transit, 78 were identified as strong candidates for TNC-based service. These results suggest that microtransit may currently be overused as an on-demand mode and that there is a large untapped market for TNC partnerships.

Future Research

The present research has limitations that suggest directions for future work. First, one important extension would be to leverage the flexibility of the proposed business plan to accommodate participation from multiple TNCs or taxi providers. Currently, the business plan is reliant on a single TNC partner, which could result in monopolistic behavior during contract negotiations. Because local trip requests go through the service manager's app and not through any one TNC's platform, the community has flexibility in how it connects requests to a provider. This opens the door for presenting requests and incentives to multiple competing providers through a marketplace structure. Each provider could bid on trips, with competition driving down per-trip costs. Providing a user interface for the marketplace could further reduce the business plan's reliance on API access and create opportunities for participation from smaller, less technology-enabled providers, such as local taxi companies or driver cooperatives.

Second, several enhancements could be made to the simulation model to better reflect real-world complexities. For simplicity, several assumptions were made when designing the simulation model, such as randomly matching requests to available drivers, assuming all drivers share the same expected wage (based on their value of time), and assuming a baseline supply of available drivers exists near each service area. These assumptions are conservative; they err on the side of underestimating TNC level of service and overestimating its costs. However, future work could relax these assumptions to add realism and refine the performance estimates. Modifications could include implementing proximity-based matching between riders and nearby drivers or simulating wage-sensitive drivers who only accept trips if their compensation meets their value of time. An urgency bonus could be introduced that increases the value of the incentive over time, to ensure that unaccepted requests eventually get served by wage-sensitive drivers. The simulation could also account for limited driver supply in isolated communities by introducing idle time compensation by paying drivers to stay for long periods of time in areas they would otherwise find unprofitable.

Third, the planning metric could be refined in several ways. One refinement would entail improving the microtransit performance curve by simulating different service area scenarios (if proprietary microtransit operating algorithms are made available) or incorporating data from many additional microtransit systems. Another refinement would be to improve the regression-based version of the metric by training the regression model on a larger dataset that reflects a more diverse set of communities (as opposed to just those in California that currently have microtransit). Additional explanatory variables could also be added to the regression, reflecting the role that household income, access to major trip generators, or local government budgets have in dictating microtransit's success. These refinements could enhance the metric's accuracy and broaden its applicability across different types of communities and service goals.

Finally, the framework used for the overall mode comparison could be expanded from comparing only two on-demand modes to include additional transit modes. While the present study focused on cost and level of service (as they are the most common measures of transit performance) future work could incorporate other community-relevant outcomes, such as greenhouse gas emissions, vehicle-kilometers traveled, user mode shift, access to employment, and social equity. Expanding the modal comparison in this way would ensure that cooperative TNC partnerships meet broader community goals in addition to efficiency.

Policy Implications

The findings from the present study carry several important policy implications for local governments, regional transportation agencies, and mobility service providers.

1) With the right incentive structures and mechanisms in place, TNC partnerships are viable and often superior alternatives to microtransit in communities with low trip consolidation potential. These partnerships should be considered as a first-choice solution in such settings. Suitable settings can be identified using the planning metric developed in this study.
2) The choice between microtransit and TNCs should be data-driven, not political. The metric introduced in this study provides a simple, accessible tool that can help planners identify the most cost-effective service type before committing significant resources.
3) The proposed business plan for cooperative TNC partnerships can address common community concerns such as data access and transparency, control over local operations, and service reliability. A community-appointed service manager can align the interests of private companies with public goals.
4) Strategic deployment matters. Neither TNC partnerships nor microtransit are one-size-fits-all solutions, and a greater emphasis should be placed on using each mode only in the communities where the mode excels. The metric formulated in this work provides a simple tool for TNCs and microtransit providers to identify these communities where their services are most likely to succeed, avoiding the reputational risks and extra community costs of failed pilots.
5) Rural and underserved communities should not be left behind. With the right incentive structures in place, isolated communities can also be well served by TNCs. Cooperative partnerships provide an opportunity to expand access to mobility in places where fixed-route transit (and even microtransit) is less effective.

In conclusion, this study equips planners and policymakers with practical tools for improving on-demand transit through smarter partnership design and mode selection. With careful implementation, the approaches developed here can reduce costs, improve service quality, and bring equitable transportation to communities that need it most.

References

1. Gonzales, E. J., E. Christofa, C. Sipetas, and University of Massachusetts at Amherst. *Flexible Transit Services*. Publication 21–020. 2021.

2. Golden, M., D. Chia, B. Ellis, and R. Thatcher. *Accessible Transit Services for All*. Publication 0081. Federal Transit Administration, 2014.

3. National Center for Applied Transit Technology. What Are On-Demand Transit and Microtransit? N-CATT, Oct 31, 2023.

4. Curtis, T., M. Merritt, C. Chen, D. Perlmutter, D. Berez, and B. Ellis. *Partnerships Between Transit Agencies and Transportation Network Companies (TNCs)*. Transportation Research Board, Washington, D.C., 2019.

5. Volinski, J. *Microtransit or General Public Demand-Response Transit Services: State of the Practice*. Transportation Research Board, Washington, D.C., 2019.

6. Tzventarny, J., and S. Minelli. *On-Demand Transit Toolkit*. Canadian Urban Transit Association, 2022.

7. Davalos,Bloomberg, J. You'll No Longer Be Able to Take a Carpool Ride with Lyft to Save Money. *Fortune*. https://fortune.com/2023/05/11/lyft-carpool-ride-eliminated/. Accessed Oct. 30, 2025.

8. Thorbecke, C. Uber Is Bringing Back Shared Rides to 9 US Cities | CNN Business. *CNN*. https://www.cnn.com/2022/06/21/tech/uber-restarting-shared-rides. Accessed Oct. 30, 2025.

9. Smith, R., J. Borkholder, M. Montgomery, and M. Saika Chen. *Uber State Interference: How TNC's Buy, Bully, and Bamboozle Their Way To Deregulation*. National Employment Law Project, 2018.

10. Collier, R. B., V. B. Dubal, and C. L. Carter. Disrupting Regulation, Regulating Disruption: The Politics of Uber in the United States. *Perspectives on Politics*, Vol. 16, No. 4, 2018, pp. 919–937. https://doi.org/10.1017/S1537592718001093.

11. Shurna, M. L., and J. P. Schwieterman. *21 Key Takeaways from Partnerships between Public Transit Providers & Transportation Network Companies in the United States*. DePaul University Chaddick Institute, 2020.

12. Blodgett, M., A. Khani, D. Negoescu, and S. Benjaafar. *Public/Private Partnerships in Transit: Case Studies and Analysis*. Minnesota Council on Transportation Access, 2017.

13. Lucken, E., K. Trapenberg Frick, and S. A. Shaheen. "Three Ps in a MOD:" Role for Mobility on Demand (MOD) Public-Private Partnerships in Public Transit Provision. *Research in Transportation Business & Management*, Vol. 32, 2019, p. 100433. https://doi.org/10.1016/j.rtbm.2020.100433.

14. Grahn, R., C. D. Harper, C. Hendrickson, Z. Qian, and H. S. Matthews. Socioeconomic and Usage Characteristics of Transportation Network Company (TNC) Riders. *Transportation*, Vol. 47, No. 6, 2020, pp. 3047–3067. https://doi.org/10.1007/s11116-019-09989-3.

15. Benaroya, A., M. Sweet, and R. Mitra. On-Demand Ride Hailing as Publicly Subsidized Mobility: An Empirical Case Study of *Innisfil Transit*. *Case Studies on Transport Policy*, Vol. 11, 2023, p. 100944. https://doi.org/10.1016/j.cstp.2022.100944.

16. Banerjee, T., D. Bahl, A. Eisenlohr, H.-T. Jamme, N. Ahmed, C. Barnes, X. Fang, METRANS Transportation Center (Calif.), U. of S. C. Pacific Southwest Region 9 UTC, University of Southern California. Sol Price School of Public Policy, and Arizona State University. *Innovations in Transit? An In-Depth Case Study of the City of Monrovia/Lyft Public-Private Partnership to Increase Transit Ridership in Suburbia*. Publication PSR-19-19. 2021.

17. Correia, B. *Staff Report: Innisfil Transit -- 2024 Results and Update*. Town of Innisfil, 2025.

18. Jamme, H.-T., A. Eisenlohr, D. Bahl, and T. Banerjee. Ride-Hailing to Rail in the Suburbs: Can Subsidized Rides Enhance First and Last Mile Access for the Carless? *Findings*, 2023. https://doi.org/10.32866/001c.82216.

19. Sweet, M., R. Mitra, and A. Benaroya. *Innisfil Transit System Performance*. Ryerson University, 2021.

20. Mason, D., and M. Menard. *The Impact of Ride Hail Services on the Accessibility of Nonprofit Services*. Publication 1357. National Institute for Transportation and Communities, Portland, OR, 2021.

21. Shariat, N., D. Yang, and R. Jayakrishnan. Partnering with Transportation Network Companies (Tncs) for Low-Demand Service: Is It Viable and Beneficial for Transit Agencies? https://papers.ssrn.com/abstract=5000026. Accessed Feb. 13, 2025.

22. Daganzo, C. F. An Approximate Analytic Model of Many-to-Many Demand Responsive Transportation Systems. *Transportation Research*, Vol. 12, No. 5, 1978, pp. 325–333. https://doi.org/10.1016/0041-1647(78)90007-2.

23. Daganzo, C. F., and Y. Ouyang. A General Model of Demand-Responsive Transportation Services: From Taxi to Ridesharing to Dial-a-Ride. *Transportation Research Part B: Methodological*, Vol. 126, 2019, pp. 213–224. https://doi.org/10.1016/j.trb.2019.06.001.

24. Estrada, M., J. M. Salanova, M. Medina-Tapia, and F. Robusté. Operational Cost and User Performance Analysis of On-Demand Bus and Taxi Systems. *Transportation Letters*, Vol. 13, No. 3, 2021, pp. 229–242. https://doi.org/10.1080/19427867.2020.1861507.

25. Little, J. D. C. A Proof for the Queuing Formula: L = λW. *Operations Research*, Vol. 9, No. 3, 1961, pp. 383–387. https://doi.org/10.1287/opre.9.3.383.

26. Liu, Y., and Y. Ouyang. Planning Ride-Pooling Services with Detour Restrictions for Spatially Heterogeneous Demand: A Multi-Zone Queuing Network Approach. *Transportation Research Part B: Methodological*, Vol. 174, 2023, p. 102779. https://doi.org/10.1016/j.trb.2023.102779.

27. Ashkrof, P., F. Ghasemi, R. Kucharski, G. Homem De Almeida Correia, O. Cats, and B. Van Arem. The Implications of Drivers' Ride Acceptance Decisions on the Operations of Ride-Sourcing Platforms. *Transportation Research Part A: Policy and Practice*, Vol. 192, 2025, p. 104362. https://doi.org/10.1016/j.tra.2024.104362.

28. Merlin, Dr. L. A. Comparing Automated Shared Taxis and Conventional Bus Transit for a Small City. *Journal of Public Transportation*, Vol. 20, No. 2, 2017, pp. 19–39. https://doi.org/10.5038/2375-0901.20.2.2.

29. Liu, J., K. M. Kockelman, P. M. Boesch, and F. Ciari. Tracking a System of Shared Autonomous Vehicles across the Austin, Texas Network Using Agent-Based Simulation. *Transportation*, Vol. 44, No. 6, 2017, pp. 1261–1278. https://doi.org/10.1007/s11116-017-9811-1.

30. Grahn, R., S. Qian, and C. Hendrickson. Optimizing First- and Last-Mile Public Transit Services Leveraging Transportation Network Companies (TNC). *Transportation*, Vol. 50, No. 5, 2023, pp. 2049–2076. https://doi.org/10.1007/s11116-022-10301-z.

31. Chow, J. Y. J., S. Rath, G. Yoon, P. Scalise, and S. A. Saenz. Spectrum of Public Transit Operations: From Fixed Route to Microtransit. 2020.

32. Harmony, X. Can Transportation Network Companies Replace the Bus? An Evaluation of Shared Mobility Operating Costs. *Transportation Planning and Technology*, Vol. 45, No. 2, 2022, pp. 138–158. https://doi.org/10.1080/03081060.2022.2080677.

33. Nourbakhsh, S. M., and Y. Ouyang. A Structured Flexible Transit System for Low Demand Areas. *Transportation Research Part B: Methodological*, Vol. 46, No. 1, 2012, pp. 204–216. https://doi.org/10.1016/j.trb.2011.07.014.

34. Wright, S. Designing Flexible Transport Services: Guidelines for Choosing the Vehicle Type. *Transportation Planning and Technology*, Vol. 36, No. 1, 2013, pp. 76–92. https://doi.org/10.1080/03081060.2012.745757.

35. City of West Sacramento. Request 24-184 - NextRequest - Modern FOIA & Public Records Request Software. https://westsacramento.nextrequest.com/requests/24-184. Accessed Jun. 12, 2025.

36. City of Cupertino. Request 23-87 - NextRequest - Modern FOIA & Public Records Request Software. https://cityofcupertinoca.nextrequest.com/requests/23-87. Accessed Jun. 12, 2025.

37. City of Cupertino. CITY OF CUPERTINO - File #: 22-11280. https://cupertino.legistar.com/LegislationDetail.aspx?ID=5840686&GUID=EB8A73EB-457B-4A4B-8837-25EC30C65619&Options=ID%7CText%7C&Search=via. Accessed Jun. 12, 2025.

38. City of Cupertino. CITY OF CUPERTINO - File #: 23-12042. https://cupertino.legistar.com/LegislationDetail.aspx?ID=6046261&GUID=D71C2350-2CE2-42DF-A79B-CE9E06317CF4&Options=ID%7CText%7C&Search=via. Accessed Jun. 12, 2025.

39. City of Cupertino. NoMad Transit for South Bay Microtransit Expansion Project - Sig.Pdf - NextRequest - Modern FOIA & Public Records Request Software. https://cityofcupertinoca.nextrequest.com/documents/23472944. Accessed Jun. 12, 2025.

40. Request 22-282 - NextRequest - Modern FOIA & Public Records Request Software. https://cpuc.nextrequest.com/requests/22-282. Accessed Aug. 5, 2025.

41. Osman, T., and S. Maury-Holmes. *An Analysis of App-Based Drivers in California*. University of California, Riverside, 2022.

42. Uber. Uber Estimate - Get a Price Estimate in Your City. *Uber Estimate*. https://www.uber.com/global/en/price-estimate/. Accessed Jun. 26, 2025.

43. Internal Revenue Service. Standard Mileage Rates. https://www.irs.gov/tax-professionals/standard-mileage-rates. Accessed Jun. 26, 2025.

44. Cervero, R., and K. Kockelman. Travel Demand and the 3Ds: Density, Diversity, and Design. *Transportation Research Part D: Transport and Environment*, Vol. 2, No. 3, 1997, pp. 199–219. https://doi.org/10.1016/S1361-9209(97)00009-6.

45. Daganzo, C. F., and Y. Ouyang. Public Transportation Systems. https://www.worldscientific.com/worldscibooks/10.1142/10553?srsltid=AfmBOoozWJ2OujG-Up-FPhdkVocwK5f1V0Ejkb_CIZrUqfMM5WYvArsU. Accessed May 19, 2025.

46. Wooldridge, J. M. *Introductory Econometrics: A Modern Approach*. South-Western Cengage Learning, Boston, MA, 2013.

47. *Highway Capacity Manual 7th Edition: A Guide for Multimodal Mobility Analysis*. National Academies Press, Washington, D.C., 2022.

48. Welcome to Transitland. https://www.transit.land/. Accessed Jun. 30, 2025.

49. Trains, Buses, People. *Island Press*. https://islandpress.org/books/trains-buses-people. Accessed Jun. 30, 2025.

50. Carolyn. Advancing Transit- Supportive Development in Chicago-Area Suburbs > Metropolitan Planning Council. Metropolitan Planning Council, Nov 19, 2024.

Appendix A: Stakeholder Incentive Formulas

This appendix presents the incentive formulas that underpin the proposed TNC partnership. Each formula is designed so that every stakeholder — drivers, the TNC, the service manager — has a financial motive to cooperate. The goal is to align each stakeholder's interests with the goals of the community while preserving equity and efficiency.

A.1 Driver Incentives

To attract drivers in high-demand areas to serve trips in a neighboring, low-density community, the service manager pays the driver an incentive. It guarantees that the driver's net wage is at least equal to that available in the nearby high-demand (urban) area.

Regular TNC Fare per Trip, F_d ($/trip)

$$F_d = \left(f_{min}, \quad f_{base} + \frac{d_d}{v} \cdot f_{hr} + d_d \cdot f_{km}\right) \#(A.1)$$

- f_{min}: Minimum fare ($/trip)
- f_{base}: Base fare ($/trip)
- f_{hr}: Time-based fare rate ($/hr)
- f_{km}: Distance-based fare rate ($/km)
- d_d: Distance to drop off rider (km)
- v: Average vehicle speed (km/hr)

Duration for a driver to complete a trip (i.e., pick up and drop off a rider), T (hr)

$$T = \frac{d_p + d_d}{v} \#(A.2)$$

- d_p: Distance to pick up rider (km)

Driver Fuel and Maintenance Cost per Trip, G ($/trip)

$$G = \gamma \cdot \left(d_p + d_d\right) \#(A.3)$$

- γ: Vehicle operating cost ($/km)

Minimum Driver Incentive, I_d ($/trip)

At a minimum, the driver incentive is set as the driver's opportunity cost of working in the low-density community instead of a nearby urban area.

$$I_d = [W \cdot T - (F_d - G)]^+ \#(A.4)$$

- W: Target hourly net wage (e.g., in nearby urban area) ($/hr)
- $[x]^+ = (0, x)$

A.2 TNC Incentive

In addition to its share of the regular TNC fare, the TNC receives a per-trip bonus. It compensates the TNC for allowing a third-party service manager to oversee trip request collection, and to cover the opportunity cost to the TNC from allowing its drivers to work in a less profitable service area.

TNC Bonus per Trip, I_{TNC} ($/trip)

$$I_{TNC} = q \cdot [W \cdot T - F_d]^+ \#(A.5)$$

- q: Negotiated fraction of the driver incentive (reflecting the TNC's share of a driver's opportunity cost)

A.3 Service Manager Compensation

The service manager is compensated through a per-trip commission and an annual bonus. The latter is received if the service manager facilitates all trips under a community budget. The bonus motivates the service manager to fulfill as many trip requests as possible, while doing so in cost-efficient ways.

Service Manager per-trip Commission, C ($/trip)

$$C = \frac{Y}{H \cdot \lambda} \#(A.6)$$

- Y: Target annual salary ($/year)
- H: Operating hours per year (hr/year)
- λ: Average hourly demand (trips/hr)

Annual Surplus Bonus, S ($/year)

$$S = p \cdot [B - H \cdot \lambda \cdot Z]^+ \#(A.7)$$

- p: Percentage of unspent funds awarded as bonus
- B: Annual budget ($/year)

- Z: Total per-trip cost ($/trip)

$$Z = F_d + I_d + F_{TNC} + I_{TNC} + C + f_{mkt} \#(A.8)$$

- F_{TNC}: TNC's share of regular TNC fare ($/trip)
- f_{mkt}: State/local taxes and marketplace fees

Appendix B: Simulation Model and Parameters

This appendix describes the simulation model used to evaluate the TNC partnership in each of the three case study communities. The simulation replicates rider demand, driver behavior, and incentive-based trip assignments to test whether the proposed business plan can outperform existing microtransit systems.

B.1 Community-Specific Inputs

Disaggregated trip request data from each case study community's microtransit system are used as the basis for the agent-based TNC model. Simulated trip requests generate at the same time and locations as in the real-world data. Simulated TNC vehicles travel at speeds drawn from empirical distributions (grouped by hour and day of week) created from the microtransit vehicle speeds (unconsolidated trips only). Several additional community-specific inputs are used in the simulation:

- Estimates of available TNC driver supply , η (drivers/km^2-hr), were derived from 2019–2020 Uber data (*40*). Estimates were calculated by averaging the number of accepted trip requests per five-minute interval, divided over the area within which drivers are likely to respond to incentives. The latter was taken to be the circular area around each low-density community with radius equal to the community's distance from the closest urban center.
- TNC driver wages in nearby urban centers (Sacramento or San Jose), adjusted to 2024 dollars (*41*).
- TNC fare parameters obtained from Uber's 2024 fare estimator (*42*)

Parameter values used in the simulation model are presented in **Table B.1**.

Table B.1. Simulation inputs for each case study community

Community	TNC Driver Density, η (drivers/km^2-hr)	Nearest urban area net wage, W ($/hr)	Minimum TNC fare, f_{min} ($/trip)	Base TNC fare, f_{base} ($/trip)	Time-based fare rate, f_{hr} ($/hr)	Distance-based fare rate, f_{km} ($/km)
West Sacramento	0.047	39	6.46	1.96	8.40	0.53
Cupertino	0.150	43	7.97	2.57	22.20	0.54
Rocklin/Loomis	0.021	39	6.46	1.96	8.40	0.53

Several additional inputs were estimated to calculate the simulated TNC partnership costs. Fuel and maintenance costs were valued at $0.42/km (IRS 2024 rate) (*43*). Regular TNC fees, TNC bonus percentages, and the service manager salary were modeled under low-pricing and high-pricing scenarios. To capture dynamic TNC fare pricing (which varies by time of day, location, demand, and driver availability), the TNC's share of the fare, F_{TNC} , was set to the minimum and maximum platform fees observed on Uber's fare calculator across the case study locations calculated at different times of day. Variation is also likely for the TNC's per-trip bonus percentage (q) and the service manager's annual salary (Y) as each depends on local conditions and contract negotiations. Value estimates were drawn from estimated TNC-driver revenue splits and salary ranges for comparable technical positions with local governments. Values for each pricing scenario are presented in **Table B.2**.

Table B.2. Simulation cost inputs for low and high pricing scenarios.

Parameter	Low Pricing Scenario	High Pricing Scenario
TNC's share of regular TNC fare, F_{TNC}	$7.50/trip	$15/trip
TNC's bonus percentage, q	25%	50%
Service manager salary, Y	$125,000/year	$250,000/year

B.2 Simulation Logic

Each simulation run proceeds chronologically through the microtransit trip request data. Each new request is offered to nearby available TNC drivers through a simulated service manager, along with an incentive. The latter is based on the distance that the driver must travel to pick up and drop off the rider. In an ideal setting, the service manager would have access to drivers' real-time locations and could calculate these distances exactly. However, due to the structure of the business plan, the service manager does not have access to the locations of idle drivers; the service manager only knows the number of drivers actively serving trips in the service area (K).

Thus, the service manager must set incentives by estimating drivers' expected pick up distances. To do so, a small, but steady baseline supply of available TNC drivers are assumed to be available in and around the community's service area. The service manager estimates the number of available drivers within the service area as $N = \eta \cdot A$, where A (km^2) is the service area's physical size and η (drivers/km^2-hr) is the driver supply density. We assume the number of drivers available in any 5-minute interval is approximately constant, making the rate a quantity over short durations of time (e.g., idle time between trips).

The service manager estimates the expected pickup distance by comparing the actual quantity of drivers demanded (those serving trips) against the estimated supply of available drivers in the service area. If the actual quantity demanded is less than the estimated supply (i.e., $K < N$), the service manager assumes there are enough available drivers in the service area to match to a new trip request. In this case, the manager determines the expected pickup distance using:

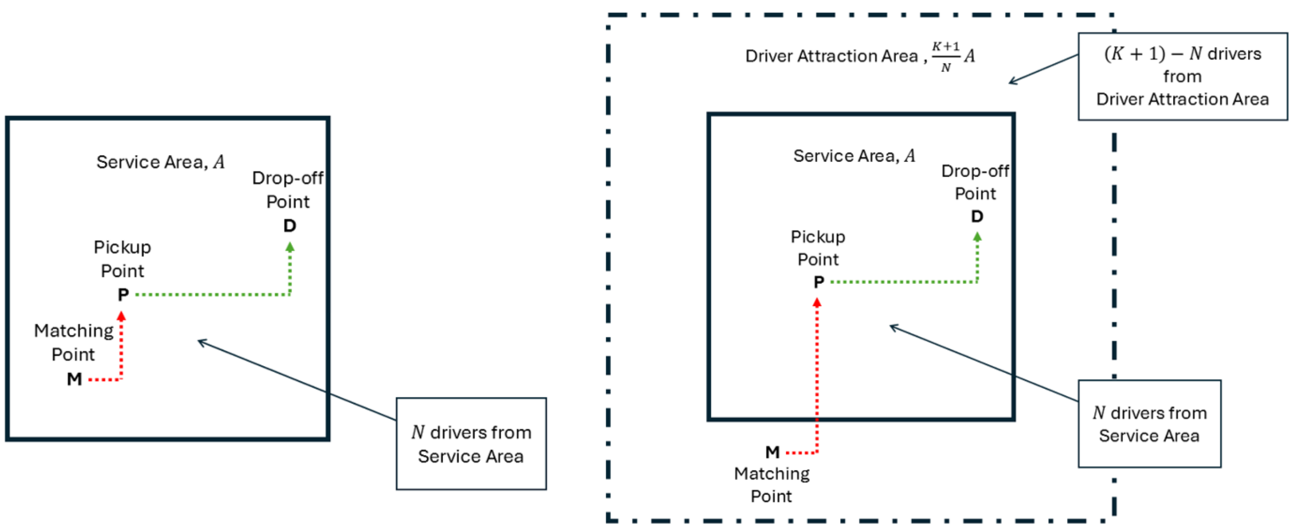
$$E\left[d_p^{(1)}\right] = \frac{2}{3}\sqrt{A}\#(B.1)$$

Equation (5.1) is the expected Manhattan distance between two random points uniformly distributed over the same square area. An example of a trip route for this case is shown in **Figure B.1a**.

If the actual quantity of drivers demanded is at least as great as the available supply (i.e., $K \geq N$), the service manager assumes there are no available drivers within the service area. The service manager must instead attract an available driver from the surrounding region. The size of this concentric "driver attraction area" is $\frac{K+1}{N} \cdot A$. Thus, the service manager estimates the pickup distance in this case using:

$$E\left[d_p^{(2)}\right] = \frac{\sqrt{A}(3 \cdot (K+1) + N)}{6\sqrt{(K+1) \cdot N}}\#(B.2)$$

Equation (B.2) is the expected Manhattan distance between a random point in a larger, square area (the driver attraction area) and a random point in a smaller, concentric square area (the service area). An example of a trip route for this case is shown in **Figure B.1b**.



a. Service when available drivers are within service area ($K < N$)

b. Service when no available drivers are within the service area ($K \geq N$)

Figure B.1. Example TNC trip route in the simulation, with the following locations labelled: the driver's location when matched with a rider (M), the rider's pickup location (P), and the rider's drop-off location (D).

All available drivers are assumed willing to accept the service manager's incentives so long as their average net wage is at least as great as the net wages in a busier urban area nearby. In other words, drivers will accept requests if driver incentives are priced using Equation (A.4). To be conservative, the trip request is randomly assigned to an available driver within either the service or driver attraction areas, depending on the service manager's evaluation of driver supply. The assigned driver serves the trip request at a speed drawn from the microtransit vehicle speed distribution for the corresponding hour and day of week of the request. The driver travels along the shortest Manhattan distance path from the matching location to the pickup location, and onward to the drop off location.

After completing the trip, the driver receives compensation, the TNC collects its share of the fare revenue and a bonus, and the service manager earns a commission. To be conservative, idle drivers (i.e., those not currently assigned to or serving a trip request) do not circulate in the service area but immediately exit the area until the estimated baseline supply, N, is reached.

B.3 Simulation Outputs and Evaluation

For each simulation run, the following outputs are recorded:

- Rider wait and on-board travel times
- Total monetary cost of service per day and cost per trip
- Average driver net wage
- Average TNC revenue
- Service manager commission

For each case-study community, these results were collected across five simulation runs and then averaged. The average measures of performance from the simulation were then compared against those from each community's existing microtransit system. This allows for an assessment of the proposed cooperative TNC partnership plan under real-world conditions.

Appendix C: Metric Estimation and Regression Model

This appendix provides technical details on the development and estimation of the proposed design-independent metric. The metric, denoted ρ (requests per average on-board time), offers a simple way to estimate a community's potential for trip consolidation, which in turn informs whether microtransit or a TNC partnership is likely to be more cost-effective.

C.1 Metric Definition

The metric is defined as:

$$\rho = \lambda \cdot \tau \# (C.1)$$

where:

- λ: average rate of trip request (trips/hr)
- τ: average time a rider spends on-board a vehicle during a trip (hr)

Equation (C.1) gives the expected number of trip requests that arrive during a typical rider's trip. Intuitively, this reflects the likelihood that a rider could share a vehicle with other riders, as trips can only be consolidated if other requests arrive while the rider is on board a vehicle. This formulation uses only two community-specific characteristics that can be derived from aggregate data. Therefore, ρ can be calculated even before a service is designed or implemented.

C.2 Approximating Metric with Proxy Variables

In communities where on-demand trip data are not available (such as where transit service does not exist), one can estimate ρ using the following proxies:

- Population density, ϕ (people/km^2), is used as a proxy for trip demand (λ)
- The square root of the service area, $\sqrt{A}$ (km), is used as a proxy for average trip time (τ)

These proxies were chosen as they reflect empirical findings in the transportation literature linking population density to demand (*44*) and spatial models relating trip length to the square root of the service area (*45*).

We use linear regression to estimate the relation between ρ and the two proxy variables, ϕ and $\sqrt{A}$. A log-log functional form is chosen, as the predictors exhibit a multiplicative relationship and span several orders of magnitude (*46*). The transformed regression model is:

$$log\ log\ (\hat{\rho})\ = \hat{\beta}_0 + \hat{\beta}_1\ log\ log\ (\phi) + \hat{\beta}_2\ log\ log\ \left(\sqrt{A}\right)\ \#(C.2)$$

The model was estimated using data from 46 California communities that currently operate microtransit services. **Table C.1** below summarizes the regression output:

Table C.1. Coefficients for the regression model that estimates the metric using proxy variables.

	Coefficient	Std Error	t	P > |t|	0.025 %	0.975 %
$\hat{\beta}_0$	-9.8521	1.281	-7.691	0.000	-12.431	-7.274
$\hat{\beta}_1$	0.8746	0.160	5.466	0.000	0.553	1.197
$\hat{\beta}_2$	1.8071	0.240	7.531	0.000	1.324	2.290

The model was statistically significant ($F(2,46) = 40.70$, $p < 0.001$) and explained 64% of the variance in ρ, with an adjusted $R^2 = 0.623$.

The coefficient estimates imply that ρ is approximately proportional to the product of population density and service area size:

$$\hat{\rho} \propto \phi A\#(C.3)$$

This suggests that the total population of a community may be a strong underlying driver of its consolidation potential, regardless of the specific layout of the service area. However, because the model was estimated using only data from communities that already operate microtransit, there may be some selection bias.

C.3 Evaluating Communities with the Metric

Estimating ρ in communities with microtransit

For communities that currently have microtransit, the metric ρ was calculated directly using average hourly demand (λ) and average travel time (τ).

These communities were selected based on criteria such as supporting smartphone-based on-demand requests and operating within a defined service area. Communities where services were exclusively reservation-based, first-mile/last-mile only, or checkpoint-based were excluded.

When demand or travel time data were unavailable:

- Hourly demand was estimated from monthly or annual ridership divided by total operating hours (obtained from publicly-available community sources).
- On-board travel time was estimated using average trip distances and an assumed vehicle speed of 30 km/hr (the average vehicle speed across the three case study communities).
- If average trip distance was also unavailable, it was estimated using the formula:

$$E[d_d] = \frac{2}{3}\sqrt{A}\#(C.4)$$

where A is the service area size in km^2.

Estimating ρ in communities underserved by public transit

Communities were classified as being underserved by public transit if the average weekday morning peak headway in a one kilometer radius centered on the community's downtown was greater than 60 minutes. This headway was selected as it is typically associated with a failing level of service (*47*). The TransitLand API was used to calculate average weekday morning peak headway for each California municipality (*48*). Out of California's 483 municipalities, 154 were classified as underserved by public transit.

Several of these communities have a population density that is high enough to support future fixed-route transit service (greater than 3000 people/mi^2, or 1159 people/km^2) (*49*, *50*). To avoid recommending TNC partnerships to communities where fixed-route transit could be viable, communities with a density above this threshold were not considered.

Because of their lack of public transit service, direct demand and on-board travel time data were not available. Instead, ρ was estimated for each community using proxy values, population density (ϕ) and the square root of the service area ($\sqrt{A}$), in the regression model in Appendix C.2. Wikipedia was used to find the values of these proxies for each community. The community's area was assumed to be the service area.