Public Microtransit Pilots in the State of North Carolina: Operational Characteristics, Costs, and Lessons Learned

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Content

Executive summary

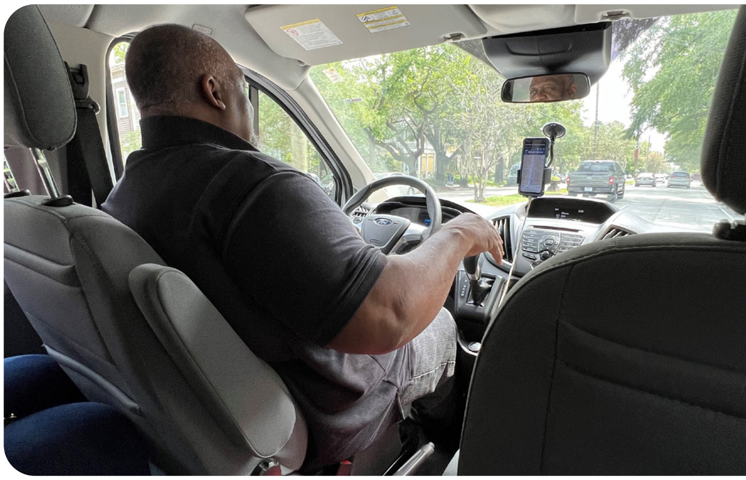
Microtransit is an emerging public transportation mode, and guidance for planning and implementation is currently lacking. Our study presents the experience of the public agencies in North Carolina that have implemented microtransit systems and seeks to contribute to an improved understanding of microtransit costs, advantages, and current challenges. We conducted semi-structured interviews with public agency representatives, reviewed the contracts between public agencies and the service providers, and examined the operational characteristics related to the service to gather adequate information about the planning and operational challenges of this new mode as well as the lessons learned from the NC implementations. All the transit agencies we studied operate the microtransit services in some form of partnership with private entities, collaborating either for software, vehicles, or for the overall operation of the service itself. We identify three different models of microtransit service delivery and the main purposes for which microtransit projects are implemented. We discuss existing challenges related to funding availability, meeting the demand under cost constraints, ADA compliance, banking and technology related barriers, virtual stops and access to vehicles, driver shortage and training, and data ownership. We also present the lessons learned from the NC microtransit implementations, including the implications of service delivery model selection, service provider selection, and marketing. The findings of this study and the lessons learned from the NC experience will assist planning and transportation agencies to plan and design successful microtransit systems.

Bottom left: Microtransit passenger and vehicle, Morrisville, NC
Top left: Microtransit vehicle, Yadkin Valley Economic Development District Inc (YVEDDI)

Right: Microtransit vehicle interior, GoWake SmartRide NE

1. Introduction

Conventional public transportation systems such as fixed route buses can be inefficient in low-density environments and unable to provide first-mile and last-mile connectivity. The recent advancements in vehicle matching and routing algorithms have presented transit agencies with an opportunity to introduce on-demand and shared mobility options into their service delivery processes. One example of an on-demand, shared mobility option that has garnered the attention of many public transit agencies in the U.S. is microtransit. Many transit agencies in the U.S. are evaluating the prospects of incorporating microtransit in their jurisdictions as a means to increase their transit coverage and provide equitable mobility services to low-income and disadvantaged populations (Mayaud et al., 2021; Volinski, 2019).



Microtransit driver, Wilmington, NC

On-demand transit is often used as an umbrella term in the literature on shared mobility to describe any form of public transport that provides flexibility in pick-up time and location. On-demand transit could include flexible transit services ranging from publicly operated taxis to simply a stop requested bus service (Currie & Fournier, 2020). Microtransit, which lies somewhere between the two aforementioned extremes, is a technology-enabled mobility option with flexible routing options developed based on real-time trip demand and origin-destination patterns. In addition, trip scheduling/requests, real-time vehicle tracking, and fare payment are incorporated into a digital interface. However, unlike traditional fixed route transportation, a microtransit service does not necessarily have a designated path, thereby largely reducing the total travel time, including waiting time, walking time, and time spent in the vehicle. Moreover, microtransit systems are mostly characterized by flexible pick-up and drop-off locations and thus have the potential to address the issue of first-mile and last-mile connections that conventional fixed route transit fails to provide. Similarly, unlike in private ridesourcing services but as in conventional public transportation, trips in a microtransit service are expected to be shared with other users while paying a nominal fare for using the service.

As an emerging mode, there is a dearth of knowledge on the benefits and costs of microtransit, compliance with federal and state requirements, and other implementation challenges. The objective of this research is to consolidate the experience of the transit agencies in North Carolina that have implemented microtransit services or a form of on-demand, shared mobility service in partnership with transportation network companies (TNCs). We conducted semi-structured interviews with the representatives of the transit agencies that have implemented microtransit or other on-demand services to understand their experience and the lessons they learned while implementing the service. We also collected information on the operational characteristics such as ridership, costs of operation, driver hours, and revenue from other sources such as requests for proposals, contracts, and operation statistics reports to augment our understanding of the microtransit services. Finally, we conducted site visits to collect first-hand experiences of using microtransit services and improve our understanding of the operational details of each service. Based on the information we collected from the interviews and other sources, we present valuable insights that the planning agencies should consider when deciding whether to invest in microtransit as well as during the planning and implementation phases of a new system.

Further, we present results from a user survey based on a limited sample to provide a preliminary understanding of the benefits of microtransit systems. The findings of this study and the lessons learned from the North Carolina experience may be used by agencies in state and the U.S. in general to plan and design successful microtransit systems.

2. Literature Review

Microtransit is increasingly gaining popularity among transit agencies to improve the quality and effectiveness of their transit service delivery (Volinski, 2019). However, being a relatively new means of public transit service, limited knowledge exists on the suitability of microtransit for a region/city and the challenges of operating a microtransit service. To inform planning and policy making processes associated with the introduction and implementation of microtransit, it is imperative to improve our understanding of the administrative and operational challenges faced by the agencies that have incorporated microtransit in their jurisdictions. To this end, some studies have made efforts to consolidate the experience of transit agencies that have either implemented a microtransit service or some form of on-demand, shared mobility option in their service area.

Based on interviews conducted with representatives from 34 different transit agencies across the U.S. that have implemented on-demand public transportation, Lucken et al. (2019) argued that microtransit systems are essentially public-private partnerships implemented to address the service gaps in traditional transit systems such as first-mile and last-mile access from and to major transit stations (Brown et al., 2021; Zuniga-Garcia et al., 2022) or as an alternative to low-frequency and unreliable fixed route bus lines (Westervelt et al., 2017). Lucken et al. (2019) highlighted that there is an increase in the popularity of publicly-owned/subsidized microtransit systems relative to partnerships with TNCs as a means of providing a flexible, on-demand transit service. The relative ease of securing operational and trip data from microtransit service providers as compared to TNCs, higher vehicle occupancy of microtransit vans, and less competition to existing fixed route service have been attributed to be some of the reasons behind the increasing popularity of microtransit. Along the same lines, Westervelt et al. (2017) presented the experience of two transit agencies that implemented a subsidized on-demand, shared mobility service and argued for the need for clear federal guidelines regarding the applicability of Title VI, environmental justice, ADA, and drug and alcohol testing rules and regulations in partnership with the service providers. Similarly, the study asserted the importance of setting best practice standards with regards to the contract and implementation process of on-demand transit services.

Microtransit passenger and vehicle, Wilmington, NC

Previous microtransit pilots have established that while microtransit would be an appealing mode of travel for individual transit users, the higher operating costs and the possibility of competition with the fixed route system poses a challenge among the operating agencies (Jokinen et al., 2019). One of the widely cited microtransit projects is a Finnish project known as Kutsuplus microtransit service that operated as a pilot project for three years from 2012 to 2015 in Helsinki, Finland. Though this service had promising customer feedback and significant prospects of alleviating car-dependency in the long run (Weckström et al., 2018), the economies of scale associated with the operation of microtransit raised concerns about the continuity of the service. The Kutsuplus service was discontinued after the pilot phase primarily because of budgetary constraints. The Kutsuplus project showed that while microtransit would be perceived by users as a flexible and convenient mode of travel that is capable of addressing their accessibility needs (Alonso-González et al., 2018) and thereby reduce car use (Weckström et al., 2018), it is a mode that entails large subsidy amounts and public/government support to sustain long-run operation (Jokinen et al., 2019). Another unintended consequence of the Kutsuplus microtransit service that was revealed from a user perception survey was that it was replacing shorter trips that the users would have completed by walking or by cycling (Weckström et al., 2018).

While multiple studies have raised concerns about the equity issues associated with ridesourcing services provided by TNCs, little is known about the role of microtransit in improving transportation equity (Palm et al., 2021). Three studies have analyzed the role of microtransit in improving accessibility to low-wage jobs among people in low-income and disadvantaged groups (Alonso-González et al., 2018; Bills et al., 2022; Kang & Hamidi, 2019). These studies suggested that microtransit significantly improved accessibility outcomes for disadvantaged groups and underserved communities. Bills et al. (2022) also asserted that the gains in accessibility from microtransit would be higher for low-income and transit dependent populations as compared to advantaged populations. A previous study that examined the user perceptions of operational microtransit services argued that microtransit services are generally preferred by transit users as compared to fixed route services (Macfarlane et al., 2021). Macfarlane et al. (2021) suggested that the on-demand microtransit service in Salt Lake City, Utah is specifically attractive among younger adults typically residing in larger households. Further, Macfarlane et al. (2021) also suggested that the users would have typically resorted to using ridesourcing services provided by TNCs if the microtransit services were unavailable, suggesting that the convenience and affordability of microtransit could provide a promising alternative to TNCs and reduce overall vehicle miles travelled (Erhardt et al., 2019).

Microtransit driver, Yadkin Valley Economic Development District Inc (YVEDDI)

Another set of studies have focused on the role of microtransit and broader shared mobility on the first-mile and last-mile access to and from transit (Jiao & Wang, 2020; Zuniga-Garcia et al., 2022). A common discussion among these studies is the need for adequate planning and careful selection of a service delivery mechanism that would be contextual to the service area characteristics. A recent research effort showed that microtransit may not always be successful in the desired objective of complementing fixed route services by aiding an increase in ridership (Zuniga-Garcia et al., 2022). However, microtransit could have the potential to establish its own niche in small rural/suburban locations if properly planned to address the needs of the service area (Zuniga-Garcia et al., 2022). In summary, previous studies arrive at a general conclusion that the on-demand transit service type should be contextual to the needs of the service area.

3. Methods

This study seeks to comprehend the operational characteristics of microtransit and on-demand transit systems in North Carolina, the costs to the agency, and the challenges faced by the public administrators during the planning and implementation of the service. An additional study objective is the classification and discussion of the existing microtransit and on-demand transit services based on service delivery models and the purpose of implementation. The methodological approach followed to address these research objectives is presented in Figure 1 and discussed in the following subsections.

3.1. Semi-structured interviews

Our research team identified ten sites in North Carolina that were either implementing microtransit or some form of on-demand transit. To gain an in-depth understanding of the experience of planning and implementing on-demand transit services, we conducted semi-structured interviews with the representatives of the public agencies in charge of the on-demand transit projects. Before the interviews took place, we reviewed the microtransit and on-demand transit literature to prepare relevant interview questions. We also explored public documents related to the microtransit projects, including requests for proposals, feasibility studies, newspaper articles, and the relevant microtransit service websites to become acquainted with the on-demand services offered and prepared a contextual script for each interview. A one-hour semi-structured interview was scheduled with each agency representative. The interviews took place between February 2022 and May 2022 and primarily centered around understanding the managerial framework, the types of contracts with service providers, costs and benefits of the project, operational characteristics (such as service hours, processes to request a trip, fleet size, ridership, service area), and the issues that arose during planning and implementation. The data collected through the interviews was compiled into spreadsheets and shared with the public agencies. Where appropriate, the interview data was complemented with information from relevant reports, planning documents, and websites. We requested each interviewee to review the data to ensure the accuracy, credibility, and completeness of the information we had compiled. We also requested additional information when needed.

3.2. Classifying on-demand transit systems by service delivery model

The administrative framework that the public agency adopts to implement the microtransit or on-demand transit service constitutes an important decision during the planning phase. Compliance with federal and state requirements, operational costs, quality of service delivery, marketing strategies, and the smooth operation of an

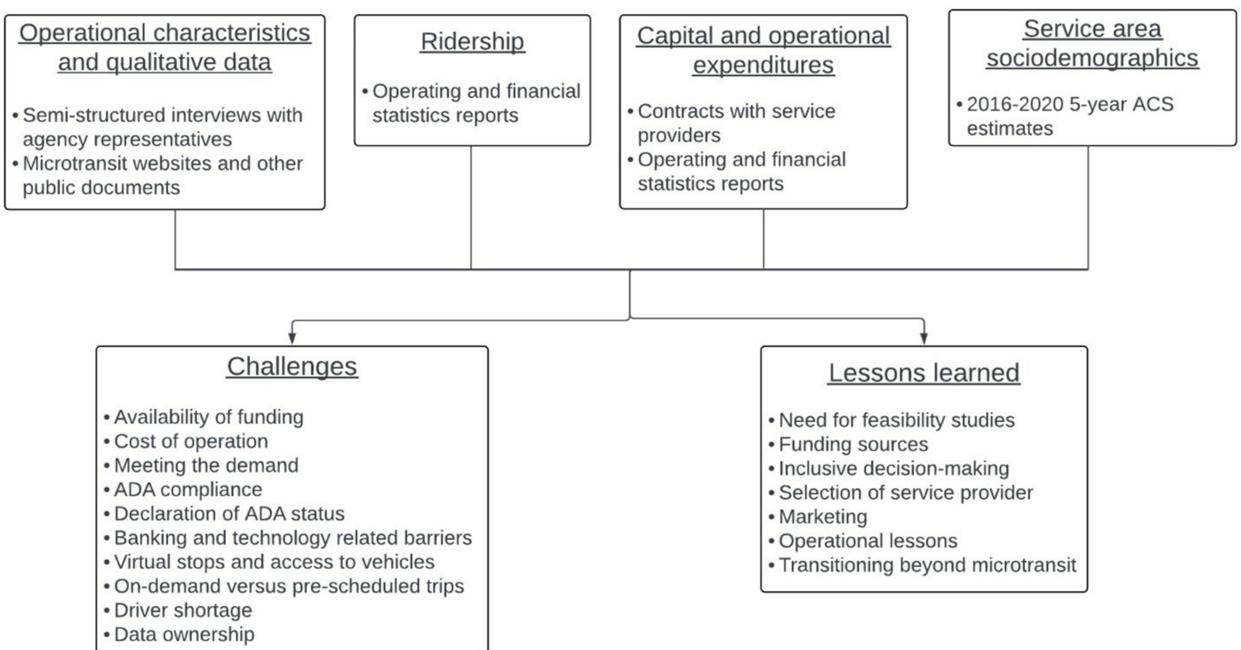


Figure 1 Study Methodology

on-demand transit service depends on the agencies entrusted with the operation and maintenance and ensuring the availability of vehicles or drivers needed to operate the service. We classify the ten on-demand transit services implemented in NC based on the contract mechanism that the public agencies put in place with either one or multiple public or private providers for procurement of software, vehicles, and drivers or for the overall operation of the service. After identifying the different service delivery models that the public agencies have adopted to implement on-demand transit services in their jurisdictions, we also discuss the relative advantages and the challenges associated with their implementation such that public agencies would be better informed about the implications associated with the selection of each service delivery model.

The script for semi-structured interviews covered questions related to the type of contract that the transit agencies had put in place with service providers to implement the on-demand transit service. We also requested the respective contracts that were put in place with service providers to review their terms in detail.

3.3. Cost information from contracts and operational statistics

To better understand the costs related to the microtransit projects in North Carolina as well as to provide some insights for transit agencies that attempt to adopt microtransit projects in the future, we collected (i) the Operating and Financial Statistics Reports of microtransit projects that were in operation during the 2022 Fiscal Year (July 1, 2021 through June 30, 2022) and (ii) the contracts formed between public agencies and private technology or vehicle/driver providers. We extracted and summarized the contract information to demonstrate differences in pricing and provisions included in each contract. We also estimate and present operational statistics, including cost per mile, revenue hour, and passenger. We note that agencies that formed contracts with TNCs were unable to share the contracts with the research team.

3.4. Sociodemographic and built environment characteristics of service areas

The sociodemographic characteristics of the service area, such as household income, vehicle availability, median age, and poverty status, could play a key role in determining the suitability of an on-demand transit system. Further, the adoption of this new mode and the demand for the service are also contingent on the sociodemographic attributes of the service area. The 2016-2020 American Community Survey (ACS) 5-year census block group and census tract estimates was used to better understand the population served by microtransit in each site. The information on total population, age group, zero-vehicle households, race, and number of households under poverty is derived from the block-group level estimates while information on vehicle-deficit households (households with fewer number of vehicles than the number of workers) and non-ambulatory population are collected from the estimates available at the census tract level. To estimate these variables for each service area, we computed the projected area of the census block group/tract that is within the service area and weighted the projected areas relative to the total area of the block group/tract that overlaps the service area using ArcGIS. For example, if P_i represents the population of block group i, and the service area overlaps with n number of block groups, the total population in the service area P is computed as follows:

$$P = \sum_{i=1}^{n} P_i \frac{a_i}{A_i}$$

3.5. Site visits

Our research team also visited some of the microtransit sites presented in this study to collect a firsthand experience of microtransit trips. The experience of using microtransit service and our perceptions on what could be improved about service delivery are also incorporated in the report.

4. Definitions

The growth of smart technologies in recent decades have brought about numerous opportunities for transit agencies, municipalities, and private companies to offer travelers new ways to meet their mobility needs. As the technologies themselves evolve, so do the ways they can be used in the transportation field. This section defines some of the often-overlapping terms that are used in the discussion around microtransit, particularly in relation to the public sector.

4.1. Fixed route

Fixed route transit is the main form of public transportation in the U.S. and uses buses, vans, trains, light rail, and other vehicles to pick up and drop off passengers on a predetermined route between designated stops using a predetermined schedule.

Microtransit vehicle, Orange County, NC

4.2. Paratransit

Paratransit is a generally government-funded (but not always government-operated) system with fully- or semi-flexible routing and scheduling. The Federal Transit Administration (FTA)'s National Transit Database (NTD) states that "(p)aratransit includes demand response (DR) transportation services, shared-ride taxis, car-pooling and vanpooling (VP), and jitney (JT) services" (FTA, 2022). Paratransit most often refers to wheelchair-accessible, demand response service.

4.3. Demand response

Demand response transit is a service most commonly used for low-density areas. Demand response transit utilizes small or medium vehicles, such as cars, vans, or small buses, to pick up passengers at their request to take them to their destination. This service has generally involved the passenger or their proxy calling the operator who dispatches the vehicles immediately, but may also involve advanced reservations or a subscription service. The vehicles have no fixed route or schedule and are usually intended to pick up and bring as many passengers as possible to their destinations, as logistically and economically as possible.

4.4. On-Demand ride services by transportation network companies

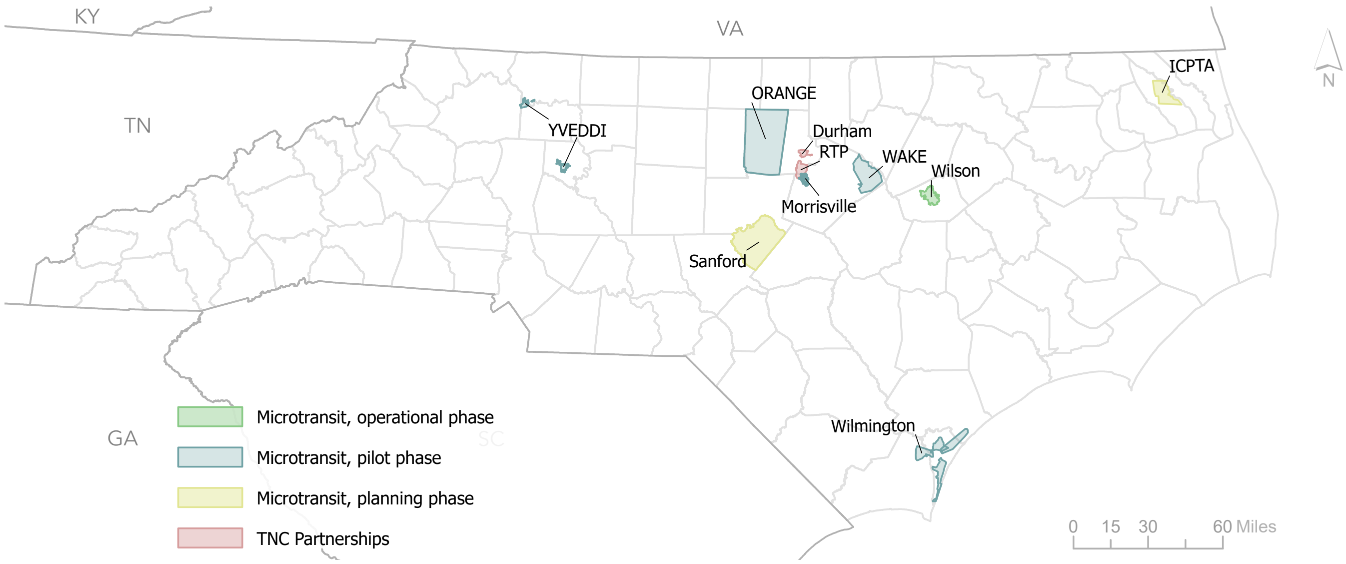
Advances in smartphone applications in recent years have allowed the emergence of transportation network companies (TNCs), like Uber and Lyft, and enabled taxicab companies to institute e-hailing/ridehailing services (Shaheen et al., 2018). Passengers are able to request rides on-demand or in advance to book rides to their destinations while paying with their phones. Rates may vary based on demand or other factors. Regulations vary across municipalities, but some systems allow shared rides between passengers to different destinations for reduced rates.

4.5. Microtransit

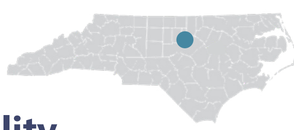
Microtransit is a form of on-demand, public transportation with flexible routes. Passengers use smartphones, web pages, or telephones to request trips, either instantly or in advance, depending upon the operator, with some systems allowing curb-to-curb service and others having pre-determined stop locations (Shaheen et al., 2019). Most systems use shuttles or vans, which are intended to bring passengers from multiple origins to multiple destinations on shared trips.

5. Site description

The context of the microtransit/on-demand mobility systems that we explore in this study are presented in this section.



Microtransit service areas



5.1. Orange County Mobility On-Demand (MOD)

(Start date: March 2020)

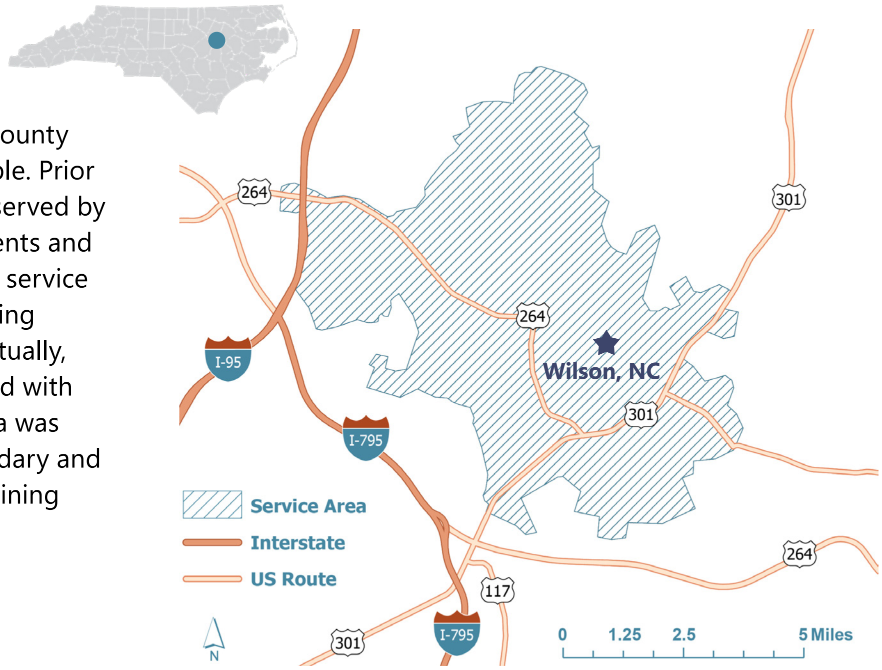
Orange County includes the urbanized areas of Chapel Hill and Hillsborough in addition to substantial rural areas. Chapel Hill Transit provides fixed route transit to Chapel Hill, GoTriangle operates service connecting Hillsborough to Chapel Hill, and Orange County Public Transportation (OCPT) provides fixed route service to Hillsborough and demand response transportation throughout the County. This service uses an on-demand model to expand OCPTs service availability to Friday evening and Saturday during the day. Days and times when neither the fixed routes nor demand response transportation are available.

Orange County service area map

5.2. Wilson, RIDE

(Start date: September 2020)

The City of Wilson is the seat of Wilson County with a population just under 50,000 people. Prior to the COVID-19 pandemic, the city was served by a fixed route. Social distancing requirements and low demand necessitated changes to the service delivery model. Wilson first began requiring trip reservations for the fixed route. Eventually, the entire fixed route system was replaced with on-demand microtransit. The service area was expanded to include the entire city boundary and some additional surrounding areas containing major destinations.

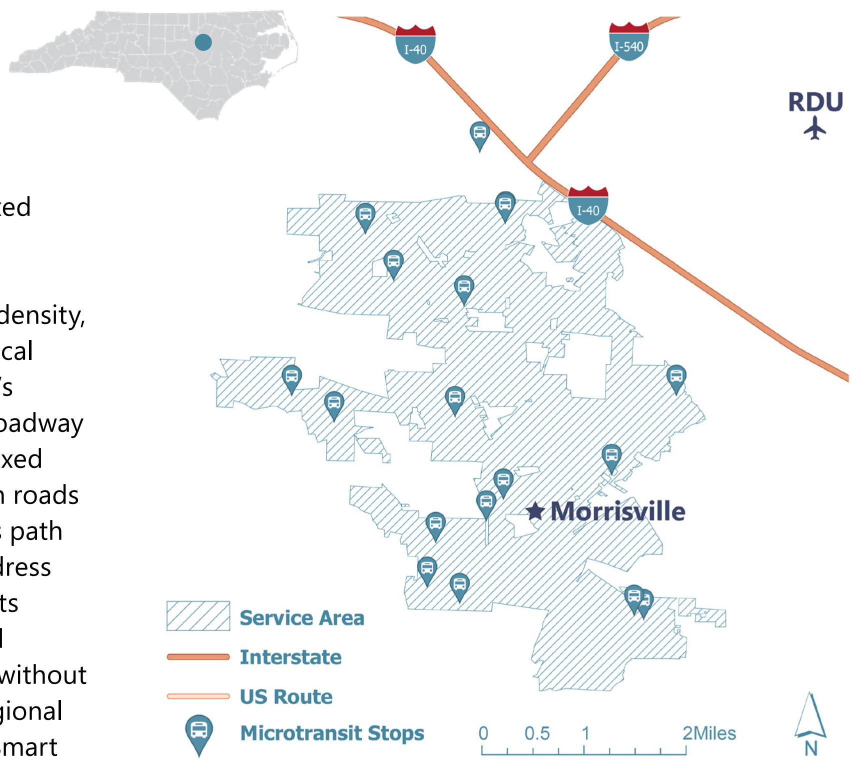


Wilson service area map

5.3. Morrisville Smart Shuttle

(Start date: October 2021)

The Town of Morrisville is surrounded by fixed route transit operators, but there were no dedicated fixed routes to serve its citizens. Morrisville has a relatively high population density, but no historic downtown or other major focal point of development. Along with the town's fragmented jurisdictional boundaries and roadway network, these challenges meant that any fixed route service would necessitate traveling on roads outside its jurisdiction or taking a circuitous path to connect people with destinations. To address these challenges, Morrisville implemented its Smart Shuttle, a point-to-point, on-demand service that connects 15 pre-defined stops without using pre-defined routes. Note that the Regional Transit Center and Parkside Commons are Smart Shuttle stops also served by GoTriangle Connect.



Morrisville service area map

5.4. Wilmington, RideMICRO

(Start date: October 2021)

Public transportation in Wilmington and both the urbanized and rural areas of New Hanover County is provided by Wave Transit. Fixed routes serve the city and adjacent areas whereas demand response is provided for rural areas. The counties of Pender and Brunswick are part of the Wilmington urbanized area but did not previously have fixed route service within their communities or to Wilmington. Wave Transit introduced RideMICRO to serve multiple purposes in four service areas. First, the on-demand microtransit service enables people in nearby areas of Pender and Brunswick counties to access key destinations in their communities and transfer to Wilmington and Wave Transit services by providing cross-jurisdictional connections. Second, Wave Transit is offering a microtransit option in areas with infrequent and hard-to-access (due to limited pedestrian facilities) fixed routes in the northern and southern extremes of the service area to enable connections to the fixed routes or origin-to-destination service within the zone.

Wilmington service area map

5.5. Wake County, GoWake SmartRide NE

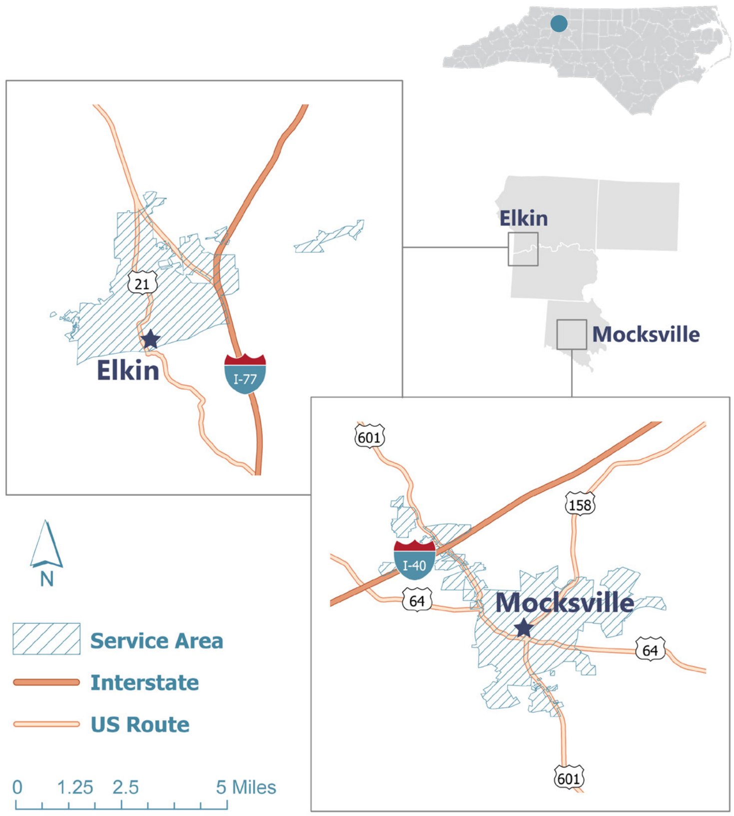
(Start date: March 2022)

Wake County contains rural areas, Raleigh, Cary, Morrisville, and many other cities and towns. GoWake provides county-wide demand response service, focusing primarily on human service transportation and rural general public trips. Northeastern Wake County is an urban-adjacent rural area with smaller cities. GoWake SmartRide NE provides on-demand transit for trips originating and ending in the northeastern part of the county, which includes fixed route connections with service to Raleigh. The on-demand service is offered in addition to the existing demand-response service.

Wake County service area map

5.6. YVEDDI, Elkin and Mocksville microtransit (Start date: July 2022)

The Yadkin Valley Economic Development District, Incorporated (YVEDDI) is the rural demand response provider for a four-county region in the northwestern foothills of North Carolina. Prior to the COVID-19 pandemic, the towns of Mocksville and Elkin had fixed route circulators. Like Wilson, social distancing requirements and low demand necessitated changes to the service delivery model, beginning with requiring trip reservations for the fixed routes. On July 1, 2022, these fixed routes were transitioned to on-demand microtransit available throughout the served communities. Demand response service is still available in these communities, but fixed route bus service is no longer an option.



YVEDDI service area map

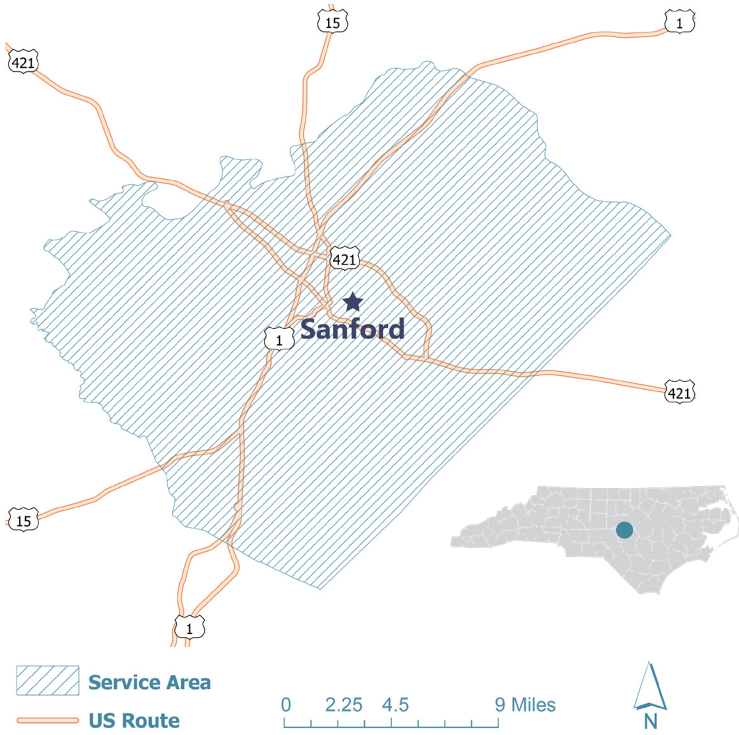
5.7. ICPTA (Planning phase)

The Inter-Choanoke Public Transportation Authority (ICPTA) serves a rural five-county region in northeastern North Carolina with demand response transportation and no fixed route service. As of February 2023, the on-demand service had not officially begun, but the service area is defined as being in and immediately around Elizabeth City, a community of less than 20,000 people. Traditional demand response service will remain in the entire service area, including Elizabeth City. The on-demand microtransit service start date is pending because technology issues need to be addressed.

ICPTA service area map

5.8. Sanford (Planning phase)

Sanford is the seat of Lee County, a small, relatively densely populated rural community. It is located in central North Carolina and within an hour's drive of many large population and employment centers. Lee County, including Sanford, is served by the County of Lee Transportation System (COLTS), which provides demand response transportation Monday through Friday from 7:30 am to 5:00 pm. Sanford is not well served by TNCs. Thus, after-hours transportation is difficult to acquire, as is on-demand mobility during regular working hours. As a result, Sanford officials are exploring the potential of implementing microtransit.

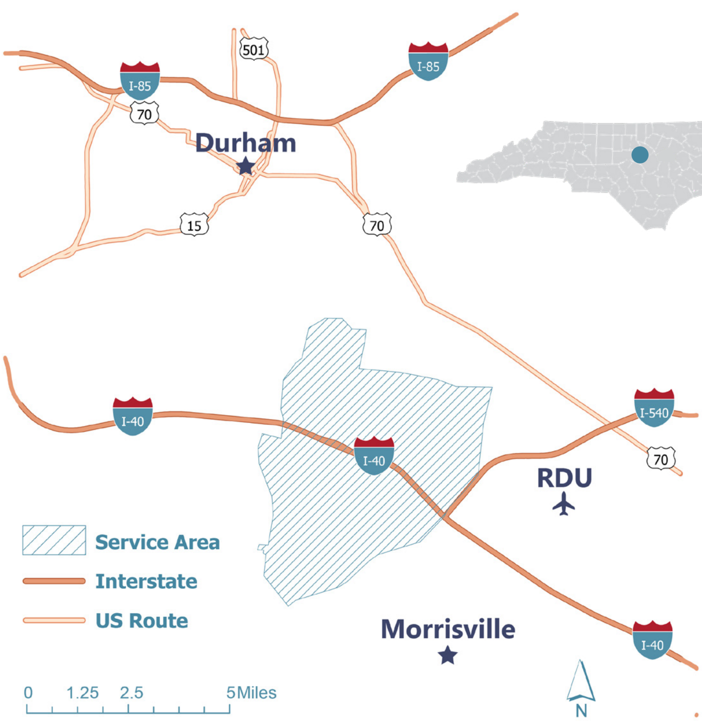


Sanford service area map

5.9. GoTriangle Connect

(TNC Partnership, Start date: August 2019)

The Research Triangle Park is a low-density employment center located between Raleigh and Durham and adjacent to Morrisville. GoTriangle provides fixed route service to many employers, but the distances between and insular nature of many of the employment campuses makes it difficult to provide effective fixed route service. GoTriangle partnered with two TNCs, Uber and Lyft, to provide $10 per trip subsidies for trips that begin or end at either the Regional Transit Center or the Boxyard, a shopping and dining destination. GoTriangle fixed route riders can travel to the transit center and then request a TNC ride to their employment site or travel from their employment site to the Boxyard for food and shopping. The fixed route service remains in place. Note that the Regional Transit Center and Parkside Commons, a large commercial complex, are included in both the GoTriangle Connect and Morrisville Smart Shuttle service areas. As a TNC subsidy, this service is not currently reported as public transportation.

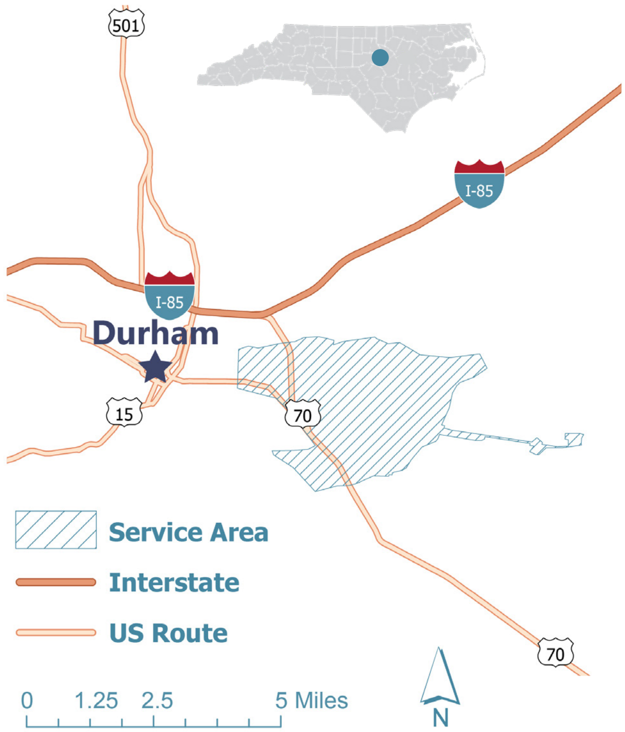


Go Triangle service area map

5.10. GoDurham Connect

(TNC Partnership, Start date: March 2022)

An area in the northeastern section of the City of Durham was identified by the city as underserved by fixed route transit. This area has infrequent GoDurham fixed route headways and a sparse pedestrian facility network for accessing the stops. The city partnered with Lyft to provide a $25 per trip subsidy for trips beginning and ending in the specified zone. Because trips must be entirely within the service zone, the fixed route service remains in place to allow people to move outside the zone. Riders can go directly to destinations within the zone or to transit stops to access points outside of the zone. As a TNC subsidy, this service is not currently reported as public transportation.



Durham service area map

6. Summary of on-demand services in NC

Table 1 highlights the sociodemographic information of the microtransit/on-demand transit implementation sites included in this study. The sociodemographic characteristics for the service areas are calculated using the methods described in Section 3.3. The service area for Sanford has not been decided as of February 2023, so the sociodemographic characteristics of Lee County are presented. Furthermore, since the Smart Shuttle in Morrisville operates as a node-to-node based service, the service area for Morrisville is considered to consist of a 0.75-mile buffer around each stop. We calculated a 0.75-mile radius buffer around each stop in keeping with the information we collected from the interviewee about the planning of the stop locations (the software provider in Morrisville considered a 0.75-mile walkshed to select the appropriate nodes). The corresponding sociodemographic information for the state of North Carolina are also presented in Table 1 for comparison.

Table 1 Summary of socio-demographics of service areas

Sites	Total population	Population density (people/ sq. mile)	Proportion of zero vehicle households	Proportion of vehicle deficit households	Proportion of non-white population	Proportion of households below poverty	Proportion of non-ambulatory population
Orange County MOD	146,354	364	5%	7%	25%	12%	7%
Wave Transit, RideMICRO	125,800	1,238	5%	4%	16%	12%	12%
Sanford	61,083	235	5%	5%	27%	15%	17%
Wilson, RIDE	40,351	1,301	12%	9%	59%	23%	15%
Morrisville, Morrisville Smart Shuttle	39,092	2,369	2%	8%	57%	3%	6%
Wake County, GoWake SmartRide NE	36,984	379	2%	4%	39%	7%	12%
ICPTA	25,968	456	8%	7%	49%	15%	15%
GoDurham Connect	20,722	2,760	10%	12%	67%	6%	10%
GoTriangle Connect	12,252	635	2%	8%	58%	3%	5%
YVEDDI, Elkin and Mocksville microtransit	5,484	378	8%	11%	17%	20%	20%
State of North Carolina	10,386,227	193	6%	5%	32%	14%	13%

6.1. Orange County Mobility On-Demand (Orange County)

PILOT PHASE

General information

- **Service area:** Orange County
- **Project type:** Microtransit
- **Turnkey:** No
- **Technology provider:** TransLoc
- **Vehicle provider:** Orange County Public Transportation
- **Driver provider:** Orange County Public Transportation (drivers are part-time)
- **Project administration:** Orange County Public Transportation
- **Data ownership:** Orange County Public Transportation
- **Service start date:** March 2020
- **Service hours:** Fri 5:00 PM - 9:00 PM, Sat 9:00 AM - 5:00 PM

Orange County microtransit service area map

Fare structure

- **Payment:** App only, no cash
- **Fare:** $5 per trip
- **Credit/Debit card:** Required

Scheduling

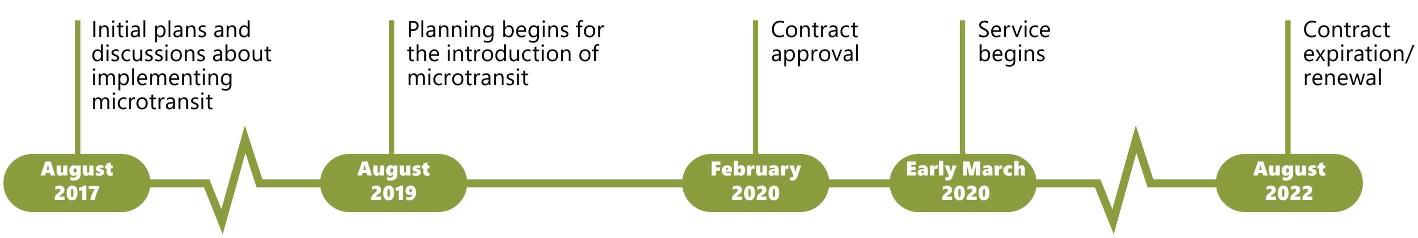
- **To schedule:** App (TransLoc), telephone, or website
- **ADA requests:** App (TransLoc), telephone, or website
- **Pre-schedule:** Not available
- **Stop locations:** Curb-to-curb
- **Wait time target:** Within 15 minutes

Orange County's on-demand microtransit service operates on weekends outside of the regular demand response hours.

Funding

- Orange Transit Plan (Local)

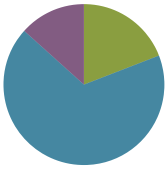
Project timeline



Service area socio-demographics

Total population: 146,354

Population density: 364 persons per sq mile



20% Population under 18
67% Population 18-64
13% Population over 64

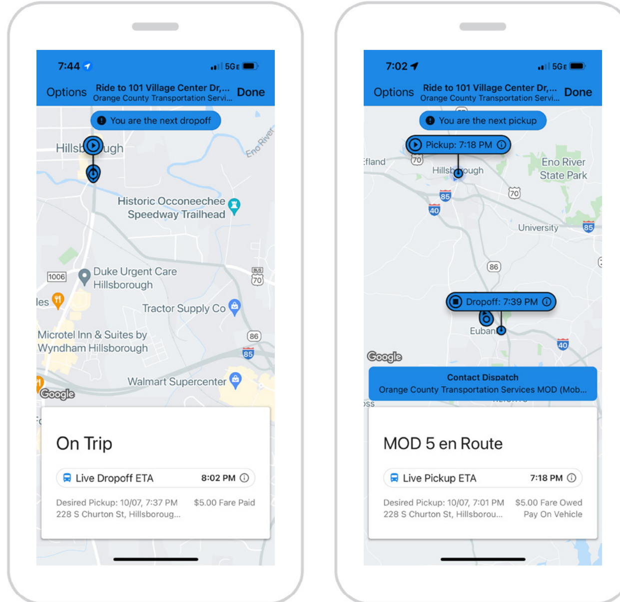
Zero-vehicle households 5%

7% Vehicle deficient households

25% Non-white

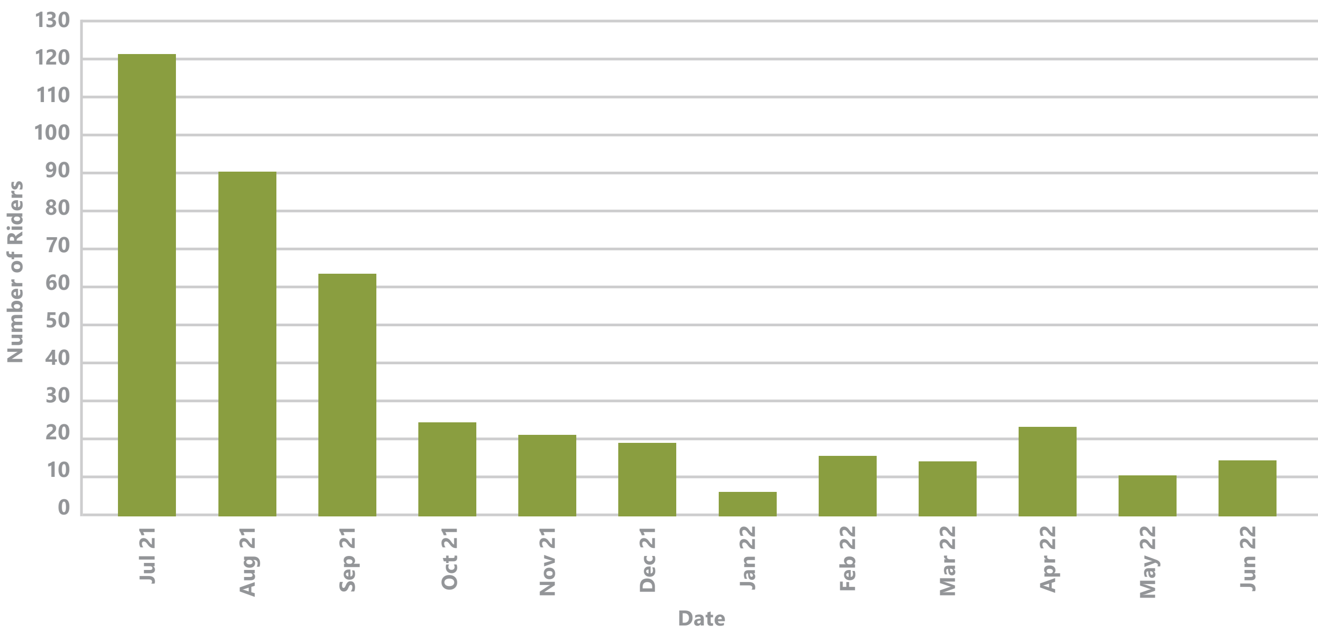
12% Below poverty

7% Non-ambulatory



App screenshots

Ridership



Fleet

- **Fleet size:** 5
- **Fleet ownership:** Orange County
- **ADA compatible:** Built-in

Marketing

- Talked with community groups

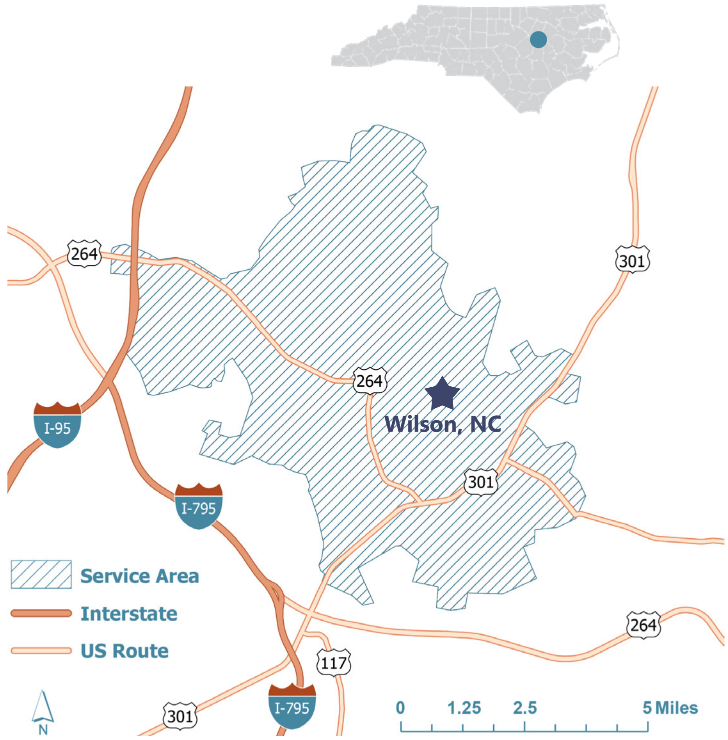
Microtransit vehicle

6.2. RIDE (Wilson)

OPERATIONAL PHASE

General information

- **Service area:** City limits plus nearby large employers
- **Project type:** Microtransit
- **Turnkey:** Yes
- **Technology provider:** Via (scheduling and routing)
- **Data ownership:** Via
- **Project administration:** City of Wilson
- **Vehicle provider:** Buggy
- **Service start date:** September 1, 2020
- **Service hours:** Mon - Fri 5:30 AM - 7:00 PM, Sat 7:00 AM - 6:00 PM



Wilson microtransit service area map

Fare structure

- **Payment:** App, cash, or ticket books
- **Fare:** $2.50/trip (additional passenger is $1)
- **Books of 20 trips:** $20

Scheduling

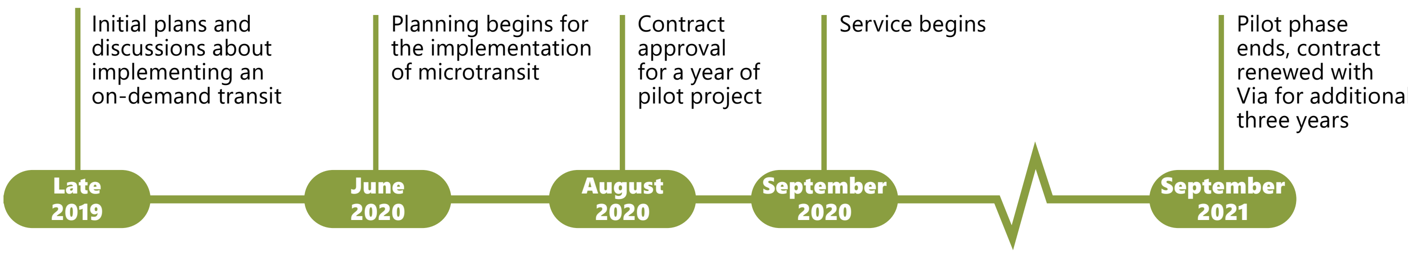
- **To schedule:** App (Via), telephone, or website
- **ADA requests:** App (Via), telephone, or website
- **Pre-schedule:** Not available
- **Stop locations:** Nearby intersections and major destinations
- **Wait times:** Within 15 minutes

Wilson's on-demand microtransit project, RIDE, replaced its entire fixed route system on September 1, 2020. The intent was to serve a greater part of the city than before and to do it more efficiently.

Funding

- Formula Grant for Rural Areas – 5311 (Federal)
- Consolidation and Coordination of Public Transit Systems – ConCPT (State)
- Local funds

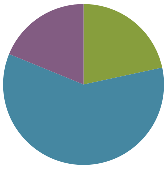
Project timeline



Service area socio-demographics

Total population: 40,351

Population density: 1,301 persons per sq mile



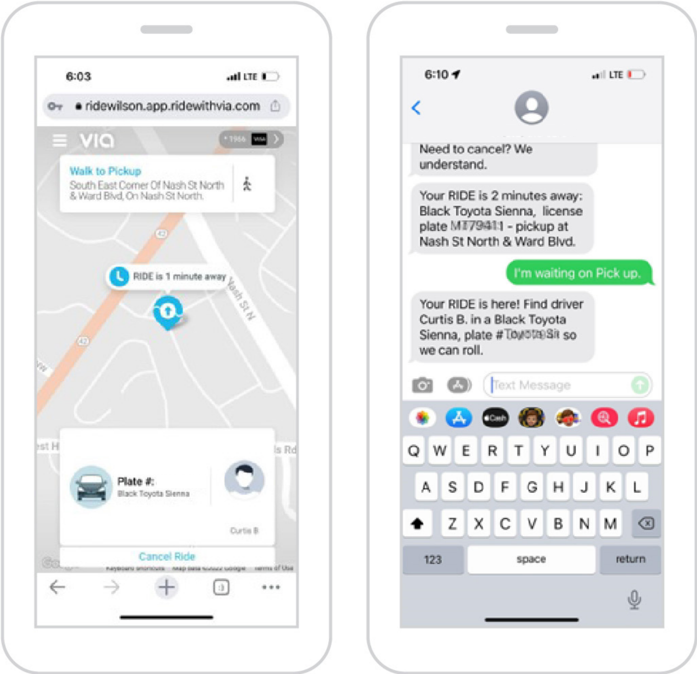
- **21%** Population under 18
- **60%** Population 18-64
- **18%** Population over 64

Zero-vehicle households **12%** **9%** Vehicle deficient households

59% non-white

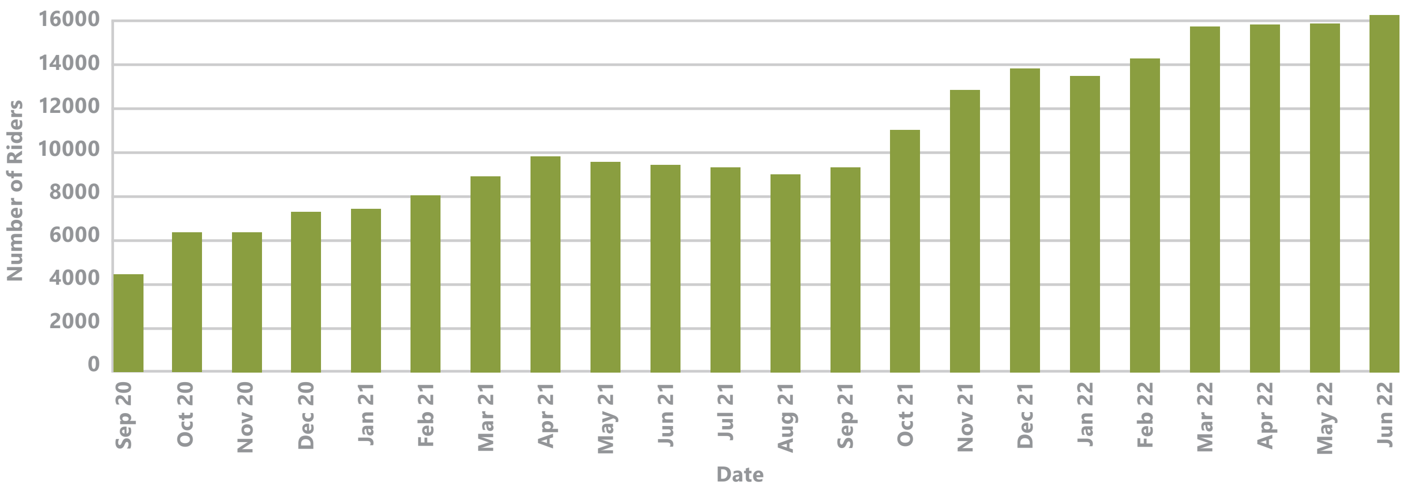
23% below poverty

15% non-ambulatory



App screenshots

Ridership



Fleet

- **Fleet size:** 26
- **Vehicles operating in maximum service:** 15
- **Fleet ownership:** individual drivers lease the vehicles from Buggy during their shifts
- **ADA compatible:** 6 vehicles are wheelchair accessible

Marketing

- **Promotions:** At start, people could get 10 free trips
- **Website:** https://www.wilsonnc.org/residents/all-departments/public-works/wilson-transit-ride-wilson-industrial-air-center/ride

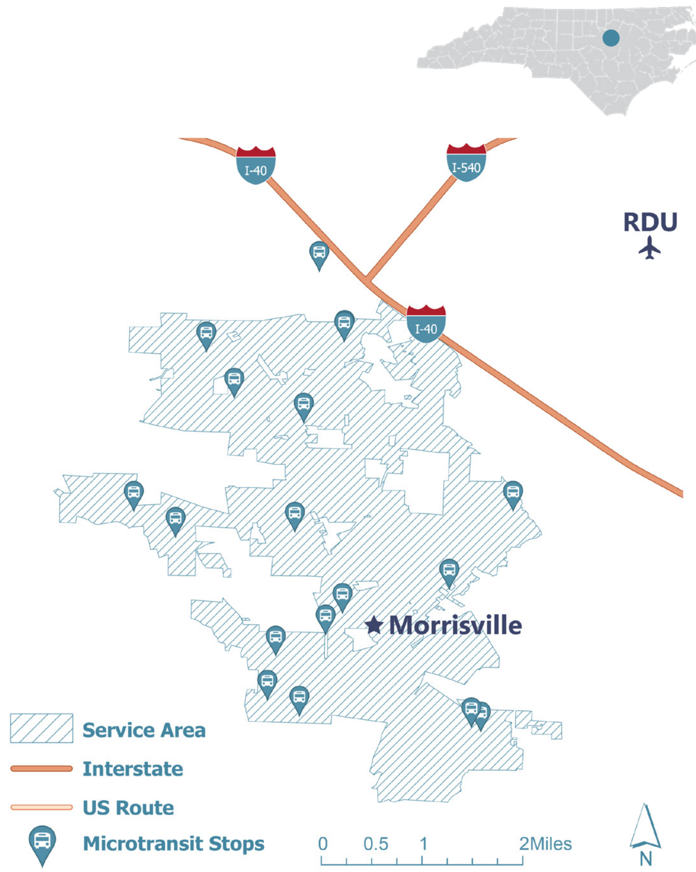
Microtransit vehicle

6.3. Morrisville Smart Shuttle (Town of Morrisville)

PILOT PHASE

General information

- **Service area:** Town limits plus the GoTriangle Regional Transit Center
- **Project type:** Microtransit
- **Turnkey:** No
- **Technology provider:** Via
- **Vehicle provider:** GoCary
- **Driver provider:** GoCary
- **Project administration:** Town of Morrisville
- **Data ownership:** Town of Morrisville
- **Service start date:** October 2, 2021
- **Service hours:** Mon - Fri 7:00 AM - 9:00 PM (2 shuttles in total, with both in service from 1:00 PM - 7:00 PM), Sat 8:00 AM - 8:00 PM (1 shuttle), Sun 8:00 AM - 7:00 PM (1 shuttle)



Morrisville microtransit service area map

Fare structure

- **Fare:** Free
- **Credit/Debit card:** Not required

Scheduling

- **To schedule:** App (Via), telephone, or webpage
- **ADA requests:** App (Via), telephone, or webpage
- **Pre-schedule:** Not available
- **Stop locations:** 14 stops with shelters within the town limit and the GoTriangle Regional Transit Center
- **Wait time target:** Within 15 minutes

Morrisville Smart Shuttle is a free, on-demand point to point microtransit service that provides mobility within Morrisville and connections to adjacent fixed routes.

Funding

- 50% from the Town of Morrisville (Local)
- 50% from the Wake Transit Plan (Local)

Project timeline

November 2019 — Approval of public transportation study conducted in October 2019. Planning begins for the implementation of microtransit

December 2020 — Issued a RFP

July 2021 — Contract approval for a year of pilot project

October 2021 — Service begins

June 2022 — Pilot phase ends, contract ends with GoCary. The agency plans to continue this service in the future

**Public agency compiles multiple contracts, including SaaS to provide microtransit service*

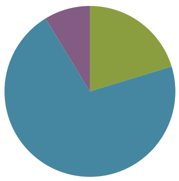
Service area socio-demographics

Total population: 39,092

Population density: 2,369 persons per sq mile

Zero-vehicle households **2%**

8% Vehicle deficient households



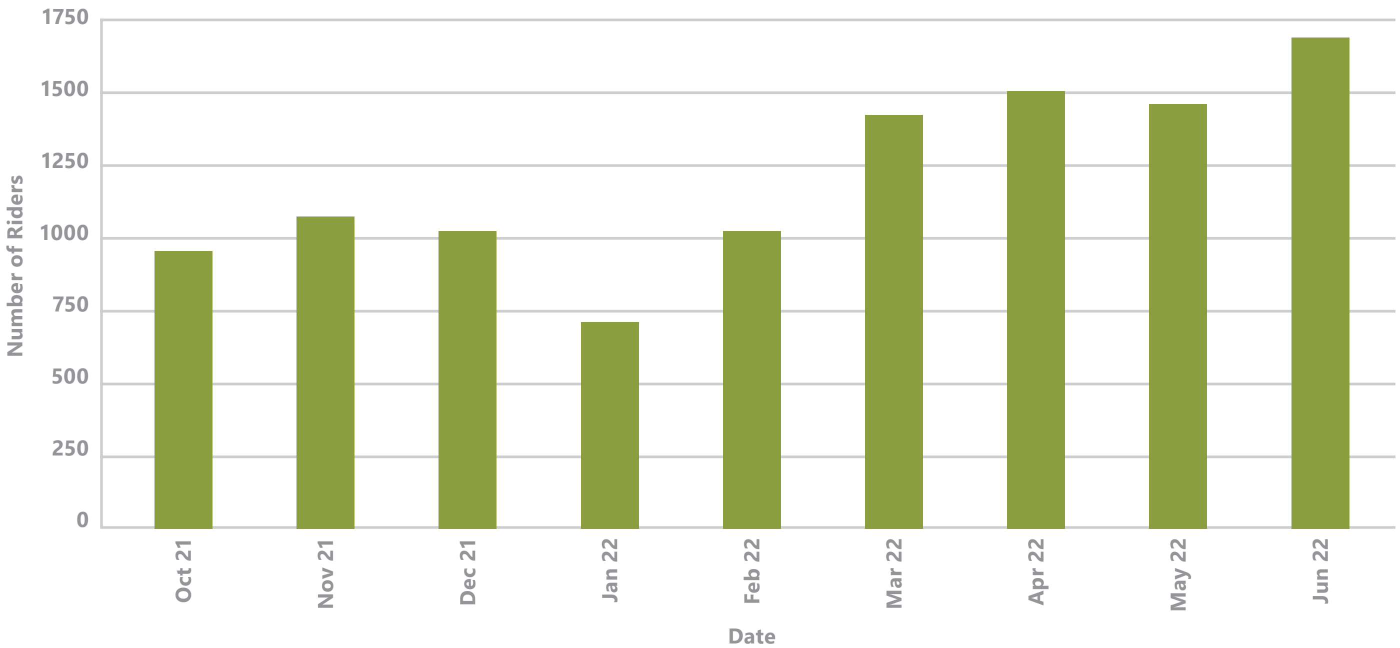
22% Population under 18
69% Population 18-64
9% Population over 64

57% Non-white

3% Below poverty

6% Non-ambulatory

Ridership



Fleet

- **Fleet size:** 2
- **Fleet ownership:** GoCary
- **ADA compatible:** Built-in

Marketing

- Sent postcards to residents
- Connected with residents through a web-based platform called Engage Morrisville
- Provided information on the service to businesses in the area
- Used social media, videos, and webpages to market the service

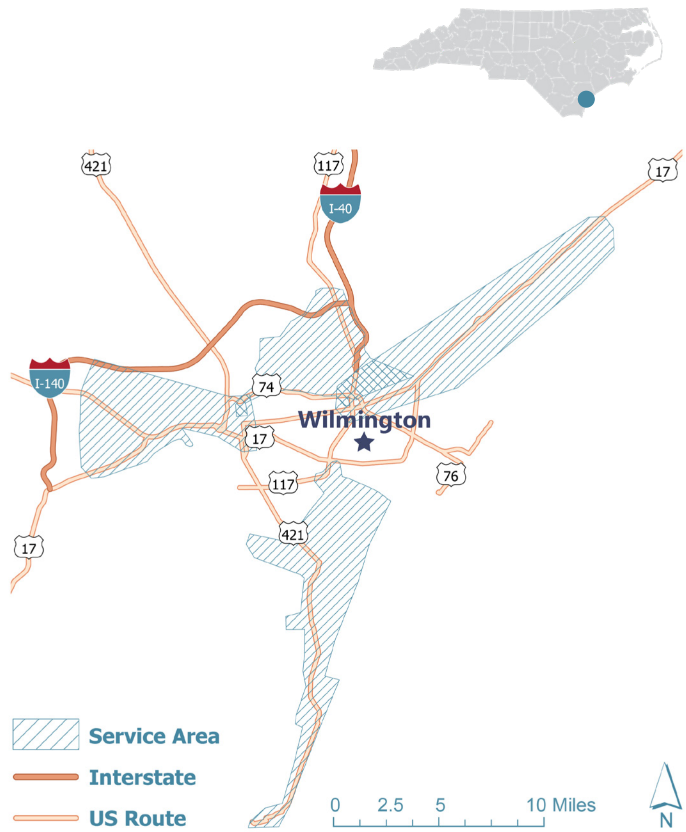
Microtransit passenger and vehicle

6.4. RideMICRO (Wilmington)

PILOT PHASE

General information

- **Service area:** Four distinct zones covering areas in Brunswick, Pender, and New Hanover Counties
- **Project type:** Microtransit
- **Turnkey:** Yes
- **Technology provider:** Bus.com (subcontractor: Moovit)
- **Vehicle provider:** Bus.com
- **Driver provider:** Bus.com (subcontractor: Daniel's Tours)
- **Project administration:** Wilmington (leader) cooperates with Brunswick Transit System Inc and Pender County
- **Data ownership:** Moovit
- **Service start date:** October 11, 2021 (first zone)
- **Service hours:** Zones 1 & 2: Mon - Fri 6:30 AM - 10:00 AM and 12:00 PM - 7:00 PM; Zones 3 & 4: Mon - Fri 6:00 AM - 8:00 PM, Sat 8:00 AM - 6:00 PM, Sun 9:00 - 5:00 PM



Wilmington microtransit service area map

Fare structure

- **Payment:** App, cash, or ticket books
- **Fare:** $2/trip
- **Discount:** The first month for each zone is free
- **Credit card:** Required unless passes are purchased

Wilmington's on-demand microtransit service, RideMICRO, operates in four areas to provide convenient mobility options within the zones and connections to fixed routes.

Scheduling

- **To schedule:** App (Moovit), telephone, or website (at least 1 hour before trip)
- **ADA requests:** App (Moovit), telephone
- **Pre-schedule:** Allow to pre-schedule trips a week in advance
- **Stop locations:** Around 3,000 fixed stops within the service area (zone 4 has common stops with zone 2 and zone 1 for transfer)
- **Wait time:** Maximum accepted wait times is 30 minutes

Funding

- North Carolina Department of Transportation ConCPT Grant ($600,000) (State)
- Community Grant ($100,000) (Local)

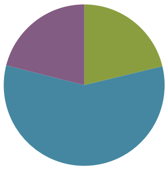
Project timeline

- **April 2021**: 1st April - Planning begins for the introduction of microtransit; 19th April - Issued a RFP
- **July 2021**: Contract approval
- **October 2021**: Service begins; service begins in zone 1
- **December 2021**: Service begins in zone 2
- **March 2022**: Service begins in zone 3
- **April 2022**: Service begins in zone 4
- **September 2022**: Contract ends with the service provider

Service area socio-demographics

Total population: 125,800

Population density: 1,238 persons per sq mile



- **19%** Population under 18
- **61%** Population 18-64
- **20%** Population over 64

Zero-vehicle households 5%

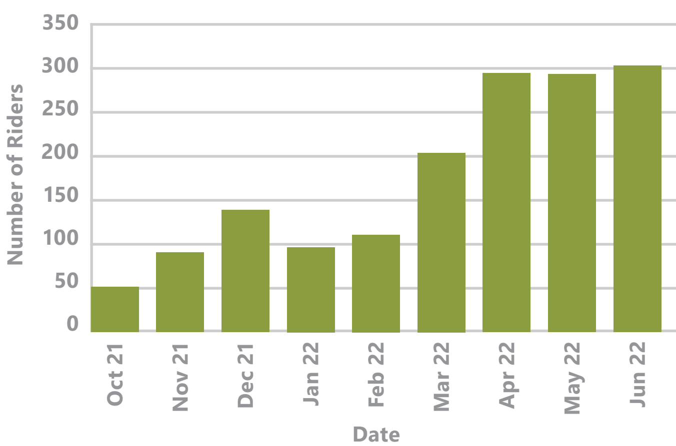
4% Vehicle deficient households

16% Non-white

12% Below poverty

12% Non-ambulatory

Ridership

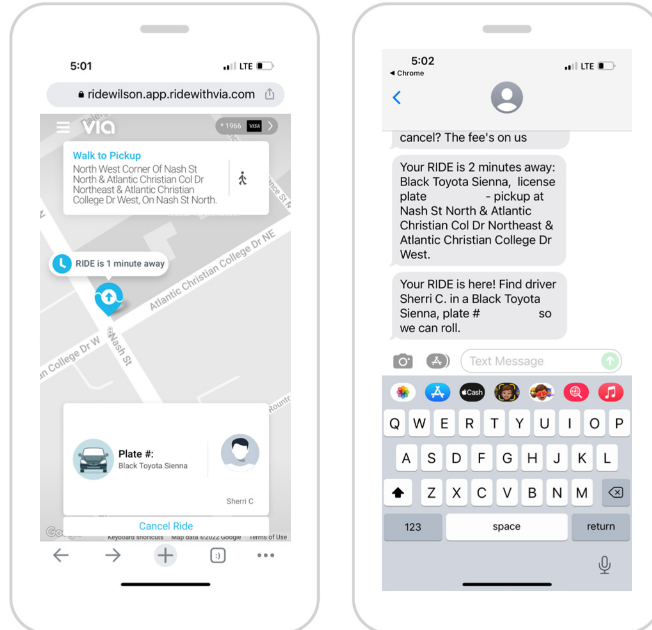


Fleet

- **Fleet size:** 5
- **Vehicles operating in maximum service:** 5 (up to 3 vehicles for New Hanover and Brunswick Counties, up to 2 vehicles for Pender County)
- **Fleet ownership:** Bus.com
- **ADA compatible:** One ADA accessible vehicle serves all 4 zones

Marketing

- Limited resources spent on marketing
- Participated and presented in meetings
- Used social media platforms and press releases

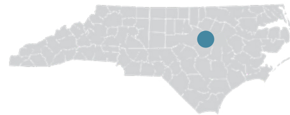


App screenshots

Microtransit vehicle

Microtransit driver

6.5. GoWake SmartRide NE (Wake County)



PILOT PHASE

General information

- **Service area:** Roughly 90 square miles in Northeastern Wake County, including Rolesville, Wendell, Zebulon, and all areas in between
- **Project type:** Microtransit
- **Turnkey:** No
- **Technology provider:** Uber
- **Vehicle provider:** MV Transportation
- **Driver provider:** MV Transportation
- **Project administration:** Wake County Health & Human Services
- **Data ownership:** Uber
- **Service start date:** March 21, 2022
- **Service hours:** Mon - Fri 6:00 AM - 7:00 PM

Wake County microtransit service area map

Fare structure

- **Payment:** App
- **Fare:** Free
- **Credit Cards:** Required if ride is requested in the app

Scheduling

- **To schedule:** App (Uber), telephone
- **ADA requests:** App (Uber), telephone
- **Pre-schedule:** Available
- **Stop locations:** Curb-to-curb with door-to-door available
- **Wait times:** Within 30 minutes

Wake County's on-demand microtransit service, GoWake SmartRide NE, was designed to provide trips from the traditional first/last mile up to 5 to 7 miles away from major destinations and regional transit connections in Wake County. It also aims to provide residents with greater accessibility to jobs, schools, healthcare, and other essential services.

Funding

- Integrated Mobility Innovation grant (Federal)
- County funds (Local)
- Wake Transit Plan (roughly $30,000) (Local)
- GoWake Program ($15,000) (Local)

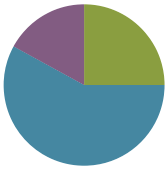
Project timeline

- **March 2020** — Initial plans and discussions about implementing microtransit
- **October 2021** — Planning begins for the implementation of microtransit
- **February 2022** — Contract approval for a year of pilot project
- **March 2022** — Service begins
- **March 2023** — Contract ends with the software provider, end of pilot phase

Service area socio-demographics

Total population: **36,984**

Population density: **379** persons per sq mile



25% Population under 18
58% Population 18-64
18% Population over 64

Zero-vehicle households 2%

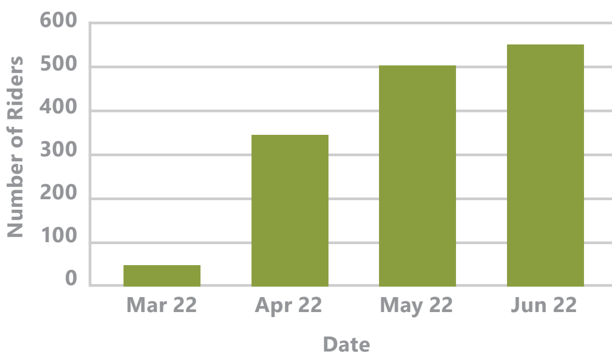
4% Vehicle deficient households

39% Non-white

7% Below poverty

12% Non-ambulatory

Ridership

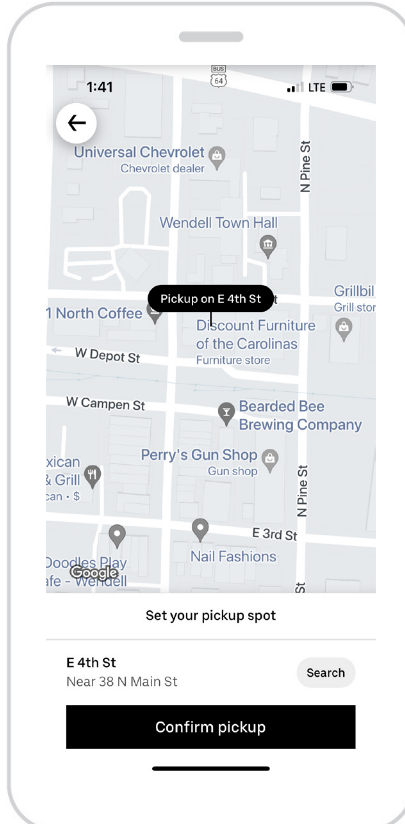


Fleet

- **Fleet size:** 3
- **Fleet ownership:** MV transit
- **ADA compatible:** Built-in

Marketing

- Mailed postcards
- Conducted focus groups
- Produced yard signs and t-shirts



App screenshot

Microtransit vehicle

6.6. Elkin Microtransit Service and Mocksville Microtransit Service

(Yadkin Valley Economic Development District Inc (YVEDDI))

PILOT PHASE

General information

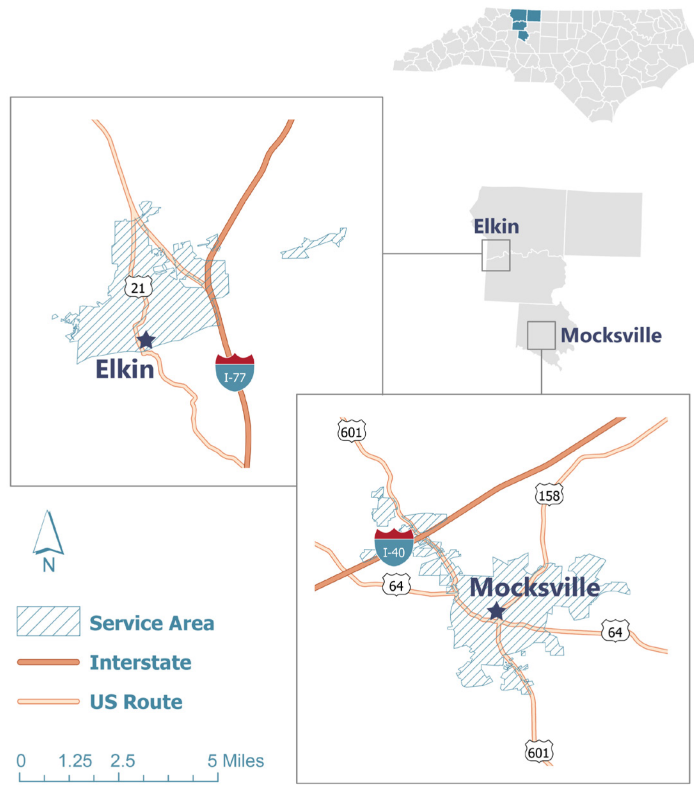
- **Service area:** Within the town limits of Mocksville and Elkin (plus Jonesville)
- **Project type:** Microtransit
- **Turnkey:** No
- **Technology provider:** CTS Software
- **Vehicle provider:** YVEDDI
- **Driver provider:** YVEDDI
- **Project administration:** YVEDDI
- **Data ownership:** YVEDDI
- **Service start date:** July 1, 2022
- **Service hours:** Mon - Fri 7:00 AM - 6:00 PM

Fare structure

- **Payment:** Cash, passes
- **Fare:** $1 per trip
- **Discount:** $30 for up to 100 trips within 30 days; $10 for up to 25 trips within the same week
- **Credit card:** Not accepted

Scheduling

- **To schedule:** App (CTS Rider Portal), telephone, or website
- **ADA requests:** App (CTS Rider Portal), telephone, or website
- **Pre-schedule:** Available (Medicaid passengers must be pre-approved and pre-scheduled to ride)
- **Stop locations:** Door-to-door service
- **Wait time target:** Within 15 minutes



YVEDDI microtransit service area map

YVEDDI's pilot program offers on-demand microtransit service in and around the towns of Elkin and Mocksville, replacing previous fixed route and pre-scheduled services.

Funding

- 50% from Formula Grant for Rural Areas - 5311 (Federal)
- 50% from Rural Operating Assistance Program (State)

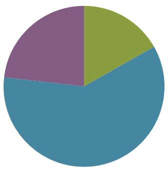
Project timeline

- **April 2020** — Emergency decision to convert the deviated fixed route to an on-demand circulator
- **March 2022** — Meeting with NCDOT for approval of microtransit
- **July 2022** — Service begins in both Mocksville and Elkin

Service area socio-demographics

Total population: 5,484

Population density: 378 persons per sq mile



17% Population under 18
60% Population 18-64
23% Population over 64

Zero-vehicle households 8%

11% Vehicle deficient households

17% Non-white

20% Below poverty

20% Non-ambulatory

Microtransit vehicle

Microtransit driver

Fleet

- **Fleet size:** 4 (2 vehicles in each town)
- **Fleet ownership:** YVEDDI
- **ADA compatible:** Built-in

Marketing

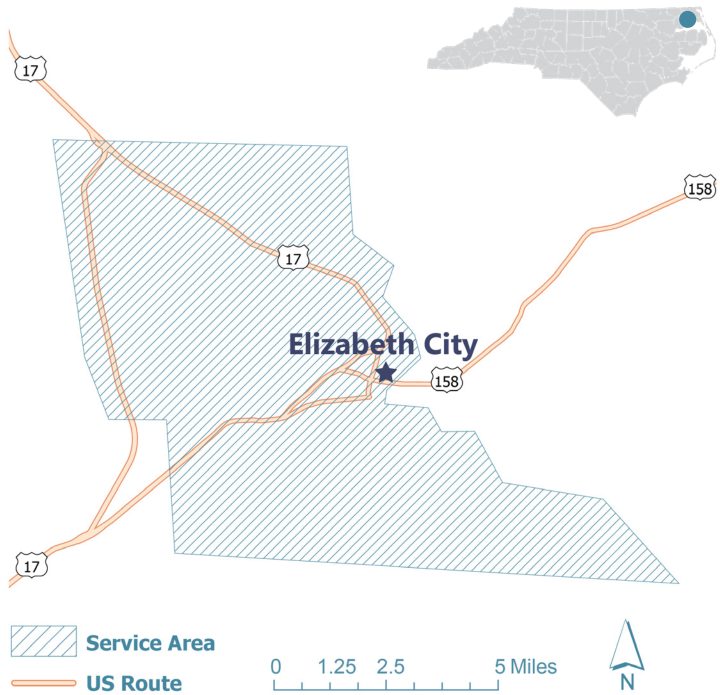
- Communicated with the town councils
- Used social media, press release and media campaigns during the pandemic
- Developing marketing plan, as the program was rushed into service due to the pandemic

6.7. ICPTA Inter County Public Transportation Authority (Elizabeth City)

PLANNING PHASE

General information

- **Service area:** Elizabeth City and 5 surrounding counties (Chowan, Perquimans, Pasquotank, Camden, and Currituck counties)
- **Project type:** Microtransit (in Elizabeth City) and pre-scheduled service (in 5 surrounding counties)
- **Turnkey:** No
- **Technology provider:** Via
- **Vehicle provider:** ICPTA
- **Driver provider:** ICPTA
- **Project administration:** ICPTA
- **Data ownership:** ICPTA
- **Service start date:** To be determined
- **Service hours:** Mon - Fri 4:30 AM - 7:30 PM
- **Age restrictions:** Children under 13 should be accompanied by adults



ICPTA microtransit service area map

Fare structure

- **Fare:** Free
- **Credit/Debit card:** Not required

Scheduling

- **To schedule:** App (Via), telephone, or webpage
- **ADA requests:** App (Via), telephone, or webpage
- **Pre-schedule:** Available
- **Stop locations:** Curb-to-curb (door-to-door when necessary)
- **Wait time target:** Within 15 minutes

ICPTA's on-demand microtransit service will provide on-demand transportation in and around Elizabeth City using public transportation vehicles and operators. Pre-scheduled demand response transportation will remain an option.

Funding

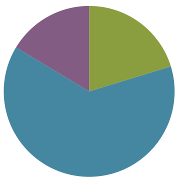
- USDOT Mobility for All Grant (Federal)

Project timeline

Service area socio-demographics

Total population: 25,968

Population density: 456 persons per sq mile



22% Population under 18
61% Population 18-64
17% Population over 64

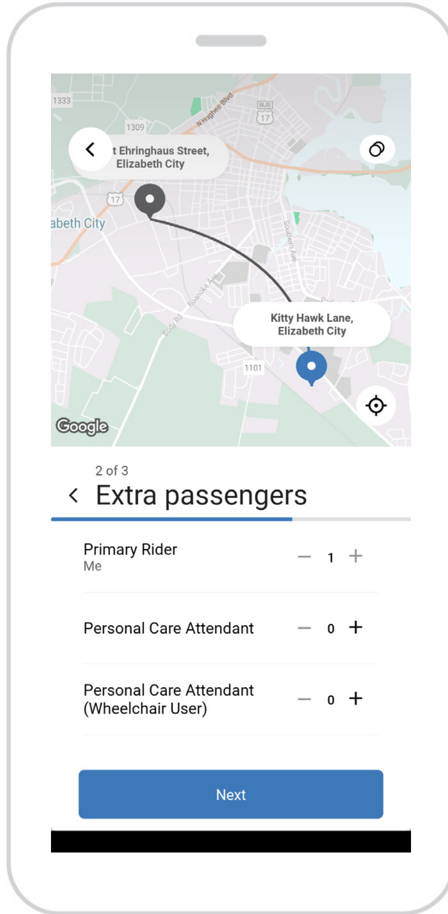
Zero-vehicle households 8%

7% Vehicle deficient households

49% Non-white

15% Below poverty

15% Non-ambulatory



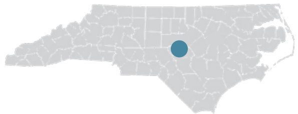
App screenshot

Fleet

- **Fleet size:** 5 available
- **Fleet ownership:** ICPTA
- **ADA compatible:** Built-in

6.8. Sanford Microtransit Project (Sanford)

PLANNING PHASE



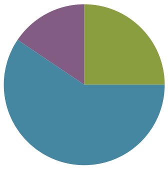
General information

- **Project administration:** City of Sanford

Service area socio-demographics

Total population: 61,083

Population density: 235 persons per sq mile



25% Population under 18
59% Population 18-64
16% Population over 64

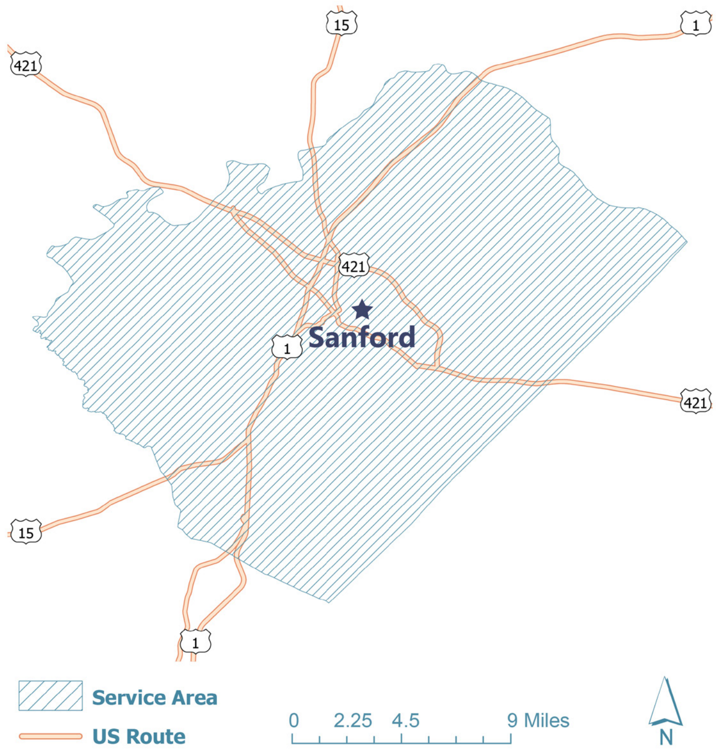
Zero-vehicle households 5%

5% Vehicle deficient households

27% Non-white

15% Below poverty

17% Non-ambulatory



Sanford and Lee County potential microtransit service area

Funding (potential)

- USDOT Rural Surface Transportation Grant (Federal)
- Future FTA Discretionary Grants for microtransit (Federal)
- Formula Grant for Rural Areas - 5311 (Federal)
- Fare and advertising revenue (Local)

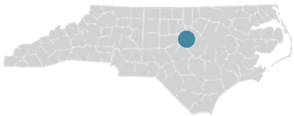
Sanford's on-demand microtransit project aims to increase access and quality of service in the community.

Project timeline

- **Winter 2021** — Initial plans and discussions about implementing microtransit
- **Dcember 2021** — Planning begins for the introduction of microtransit
- **Mav 2022** — Project team presents the service to the city council
- In the planning phase

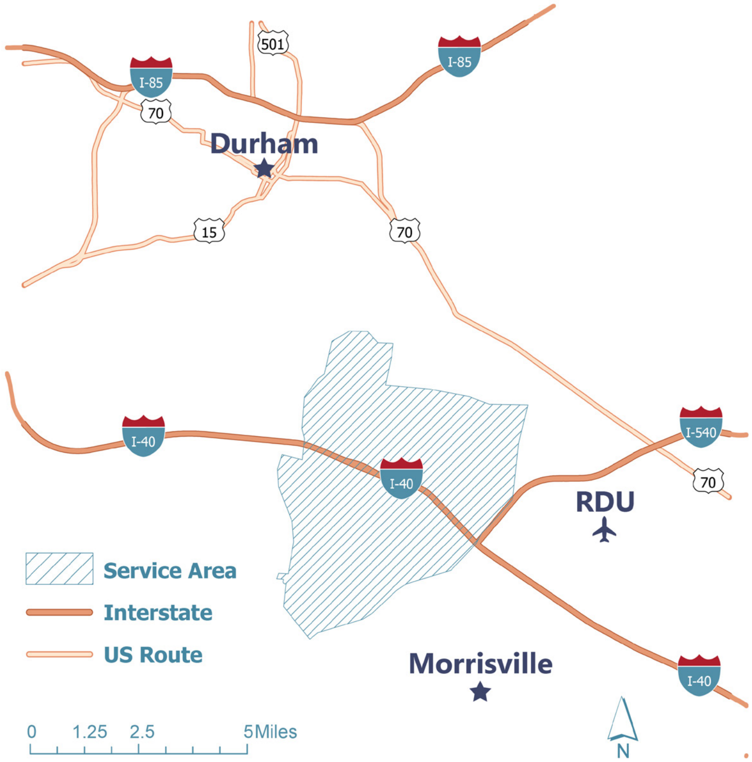
6.9. RTP Connect (GoTriangle)

PILOT PHASE



General information

- **Service area:** 20 square miles in and around Research Triangle Park
- **Project type:** Transportation Network Company subsidy
- **Technology provider:** Lyft and Uber
- **Vehicle provider:** Driver's personal vehicle
- **Driver provider:** Lyft and Uber
- **Project administration:** GoTriangle
- **Data ownership:** Lyft and Uber
- **Service start date:** August 19, 2019
- **Service hours:** Mon - Fri 6:30 AM - 10:30 PM



GoTriangle microtransit service area map

Fare structure

- **Payment:** Use the voucher link (if using Uber) or enter promo code/pass (if using Lyft) in the app (first time only) to get the subsidy
- **Fare:** $10 subsidy for each trip (user pays the excess fee)
- **Credit/Debit card:** Required

Scheduling

- **To schedule:** App (Lyft or Uber), telephone
- **ADA requests:** Telephone
- **Pre-schedule:** App (Lyft or Uber)
- **Stop locations:** Curb to/from Regional Transit Center or Boxyard RTP

Funding

- 50% from Research Triangle Foundation (Local)
- 50% from GoTriangle General Funds (Local)

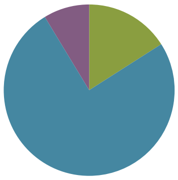
RTP Connect is a pilot program that subsidizes trips carried by on-demand Transportation Network Companies in and around the Research Triangle Park (RTP) employment cluster. The service is designed to provide a first/last mile connection to fixed route transit and a dining destination. All trips must originate from or terminate at the transit center or dining destination.

Service area socio-demographics

Total population: 12,252

Population density: 635 persons per sq mile

Zero-vehicle households 2% · 8% **Vehicle deficient households**



16% Population under 18

75% Population 18-64

9% Population over 64

58% Non-white

3% Below poverty

5% Non-ambulatory

Fleet

- **Fleet size:** Dynamic
- **Fleet ownership:** Driver's personal vehicle
- **ADA compatible:** Not available on regular Lyft and Uber trips (should call GoTriangle)

Marketing

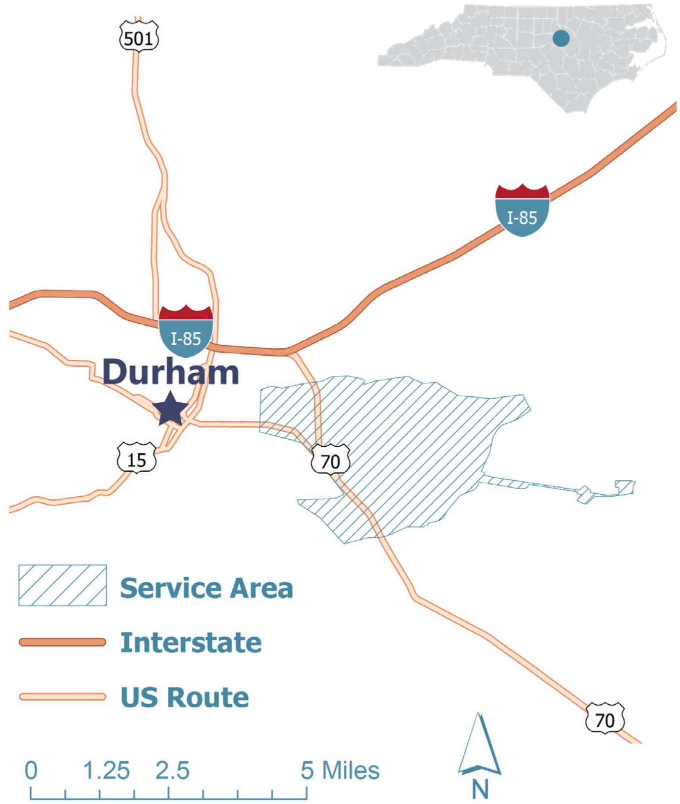
- Coordinated with employer transportation coordinators
- Promoted through business and tenant groups
- Worked with the Research Triangle Foundation's marketing group

6.10. GoDurham Connect (Durham)

PILOT PHASE

General information

- **Service area:** 7.5 square miles in East Durham
- **Project type:** Transportation Network Company subsidy
- **Technology provider:** Lyft
- **Vehicle provider:** Driver's personal vehicle
- **Driver provider:** Lyft
- **Project administration:** GoDurham
- **Data ownership:** Lyft
- **Service start date:** March 7, 2022, expansion in November 2022
- **Service hours:** Mon - Sat 7:00 AM - 8:00 PM, Sun 8:00 AM - 7:00 PM
- **Age restriction:** Children under 17 should be accompanied by adults
- **Allowed maximum trips per person:** 120 trips per month



Durham microtransit service area map

Fare structure

- **Payment:** Enter promo code in Lyft app to get the subsidy
- **Fare:** A maximum of $25 subsidy for each trip, user pays excess fee
- **Credit/Debit card:** Required

GoDurham Connect is a pilot program that subsidizes trips carried by an on-demand Transportation Network Company. The service is designed to connect people between their homes and bus stops, shopping centers, schools, and libraries for trips entirely within East Durham.

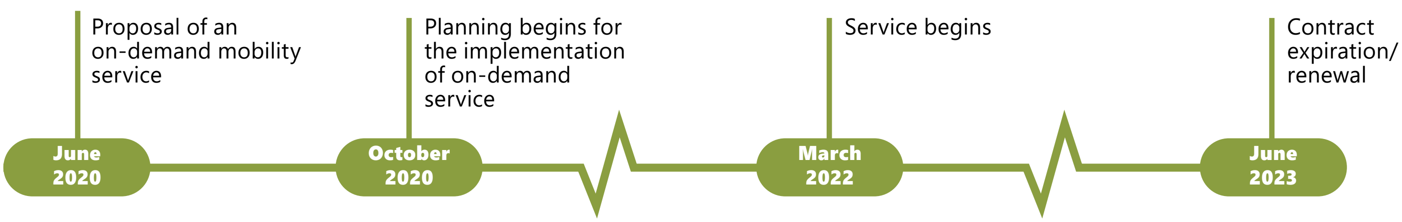
Scheduling

- **To schedule:** App (Lyft), telephone
- **ADA requests:** Telephone
- **Pre-schedule:** App (Lyft)
- **Stop locations:** Curb-to-curb service

Funding

- Durham Transit Plan (Local)

Project timeline



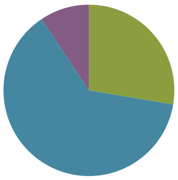
Service area socio-demographics

Total population:
20,722

Population density:
2,760
persons per sq mile

Zero-vehicle households 10%

12% Vehicle deficient households



29% Population under 18
61% Population 18-64
10% Population over 64

67% Non-white

6% Below poverty

10% Non-ambulatory

Fleet

- **Fleet size:** Dynamic
- **Fleet ownership:** Driver's personal vehicle
- **ADA compatible:** Not available on regular Lyft trips (should call GoDurham)

Marketing

- Attended tabling events and shared project information with residents prior to implementation
- Distributed instructional pamphlets among users and trained Regional Information Staff about project
- Communicated with non-profit organizations and Durham housing authority

7. Operational characteristics of on-demand services

As shown in Figure 2, we classify the on-demand services in North Carolina into three categories: i. Microtransit, ii. Shuttle service, or iii. Partnership with TNCs. Most of the on-demand services implemented in the state can be categorized as microtransit services.

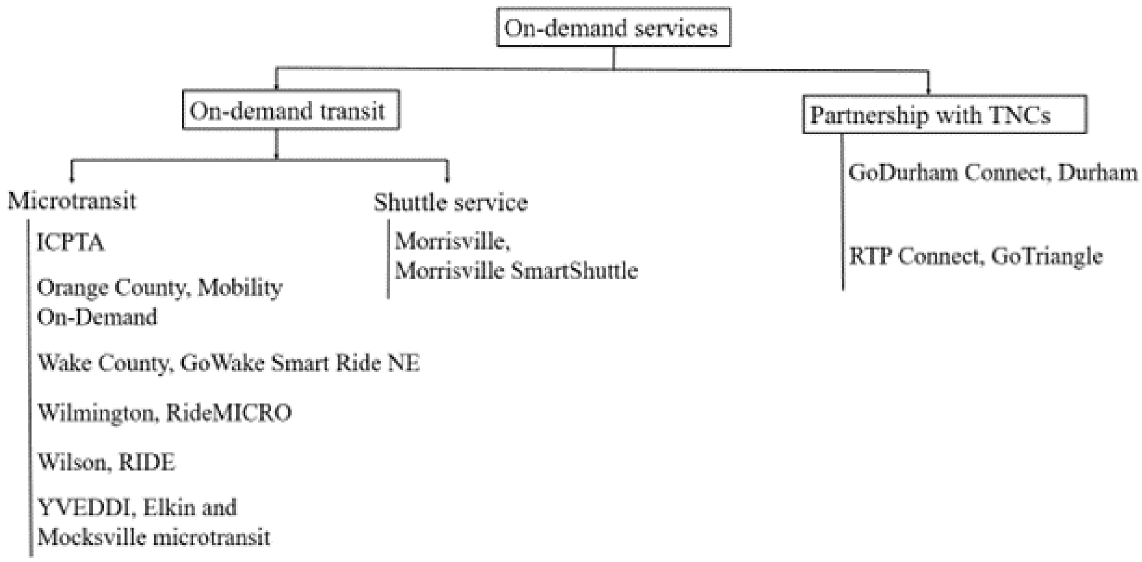


Figure 2 On-demand services assessed in this study

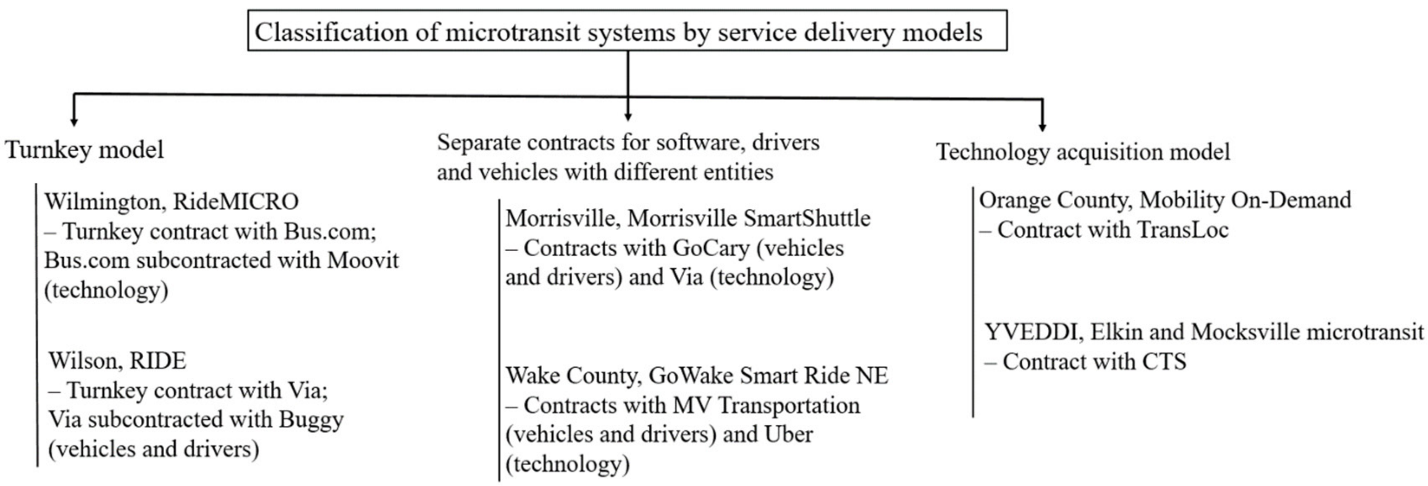


Figure 3 Classification of on-demand services based on service delivery models

7.1. Classification of microtransit by service delivery model

Based on service delivery models, on-demand transit projects can generally be classified into three categories: i. Turnkey model, ii. Separate contracts for software and drivers/vehicles with different entities, or iii. Technology acquisition model. In a turnkey model, a private company provides the software (including trip-vehicle assignment and vehicle routing algorithms), vehicles, drivers, and operations as a package solution to the transit agency. In the second model, the transit agency contracts with separate entities for the software and the vehicles/drivers needed to operate the microtransit service. In this model, where separate contracts with different partners are in place, the transit agency essentially serves as a mediator between the partner agencies to implement the microtransit service. In a technology acquisition model, the transit agency contracts with a private service provider to obtain the technology required for the daily operation of the microtransit service while owning the vehicles and ensuring the availability of drivers. In all three models, the transit agency delegates the responsibility of providing and maintaining the software to a private entity, while the technology provider tailors the digital interface to address the needs of the transit agency and maintains the ownership of the trip-level data, unless otherwise specified in the contract. We also note that for all three models of service delivery, it is the responsibility of the public agency to ensure equivalent services are being provided for those who qualify for ADA transportation.

7.2. Classification based on purpose of implementation

We classify microtransit systems into five categories based on the purpose each system serves, as shown in Figure 4. Three services in NC have the primary purpose to operate as first-mile and last-mile connections to existing fixed route services.

Another set of microtransit implementations replaced inefficient fixed route services. We note the case of Wilmington (Wave Transit), where there are multiple microtransit zones, the primary purpose of implementation differs by zone. The fixed route connecting downtown Wilmington to parts of Brunswick County was proving to be inefficient, so Wave Transit replaced the low performing fixed route with microtransit that is currently operating in Zone 3. In other zones, the primary purpose of implementation has been providing first-mile and last-mile access from and to fixed route transit stations.

Some areas that have low residential/employment density may not be suitable sites for implementing a fixed route transit service. Moreover, in towns and cities where market demand fluctuates temporally, microtransit and on-demand shuttles that adapt dynamically to changing travel patterns would be promising mobility options.

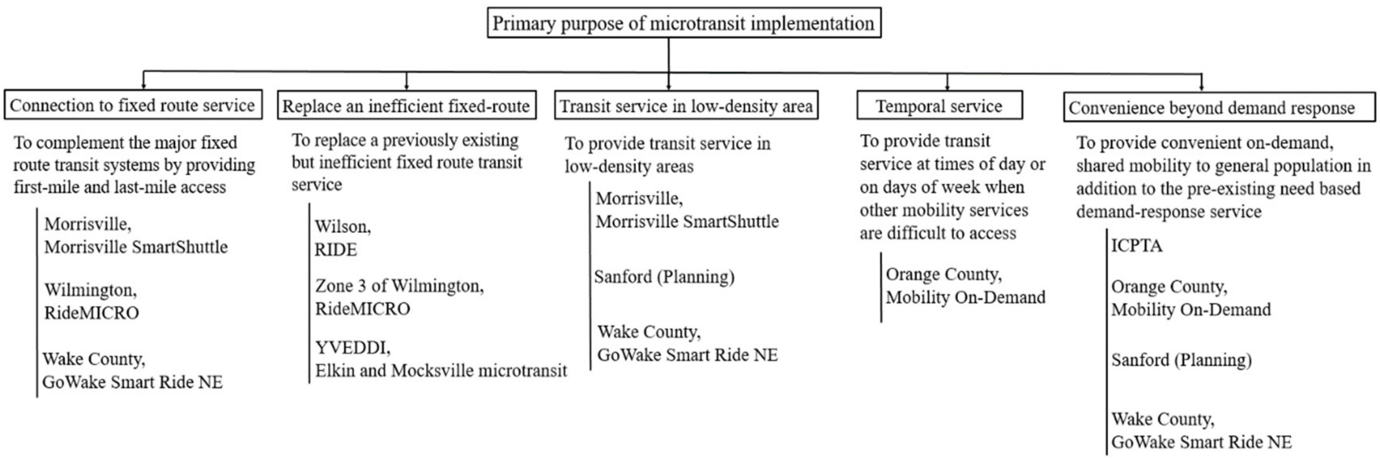


Figure 4 Classification of on-demand services based on service delivery models

Microtransit could also be implemented to provide service when other public services such as demand response and fixed route services are not available. Orange County has implemented a microtransit service to provide mobility on weekends (Saturday), during evening hours (5pm to 9pm) on Fridays, and when other services are unavailable.

Finally, areas with existing demand response services may implement on-demand transit service as a way to provide greater customer convenience and spontaneous trip-taking while continuing the current services.

We note that a microtransit system may serve multiple purposes. For instance, microtransit may be implemented to serve both as a replacement to an inefficient fixed route as well as to provide transit service in a previously underserved low-density area. Specifically, microtransit implemented in different zones in Wilmington serve different purposes. In Zone 3, microtransit has been implemented as a replacement to an inefficient fixed route, while in other zones, microtransit has been implemented as a connection to a fixed route service. Similarly, GoWake SmartRide NE in Wake County also has two implementation purposes, to provide transit service in a low-density area and to serve as a connection to fixed route services.

Table 2 Planning and administrative characteristics of microtransit systems in NC

Microtransit systems	Wilson, RIDE	Wilmington, RideMICRO	Morrisville, Morrisville SmartShuttle	Wake County, GoWake SmartRide NE	Orange County, MOD	YVEDDI, Elkin and Mocksville microtransit
Project administration	City of Wilson	Wave Transit	Town of Morrisville	Wake County Health and Human Services	Orange County Public Transportation	YVEDDI
Federal funding	Accelerating Innovative Mobility grant (AIM)	-	-	Integrated Mobility Innovation grant (IMI)	-	Federal formula grant for rural areas (5311)
State funding	ConCPT[a] Grant	ConCPT[a] Grant	-	-	-	ROAP[b]
Local funding	City of Wilson and Wilson County	Community grant	Town of Morrisville and Half-Cent sales tax	Wake County, GoWake program, Wake Transit plan	Orange Transit Plan	-
Technology provider	Via	Moovit	Via	Uber	TransLoc	CTS
Vehicle provider	Buggy	Bus.com	GoCary	MV Transportation	Orange County Public Transportation	YVEDDI
Driver provider	Buggy	Bus.com	GoCary	MV Transportation	Orange County Public Transportation	YVEDDI
Data ownership	Via	Moovit	Town of Morrisville	Uber	Orange County Public Transportation	YVEDDI

a Zones 1 and 2: Mon - Fri 6:30 AM - 10:00 AM and 12:00 PM - 7:00 PM; Zones 3 and 4: Mon - Fri 6:00 AM - 8:00 PM, Sat 8:00 AM - 6:00 PM, Sun 9:00 AM - 5:00 PM.

b Drivers may call users and request them to travel a short distance to an accessible location in some cases.

Table 3 Operational characteristics of microtransit systems in NC

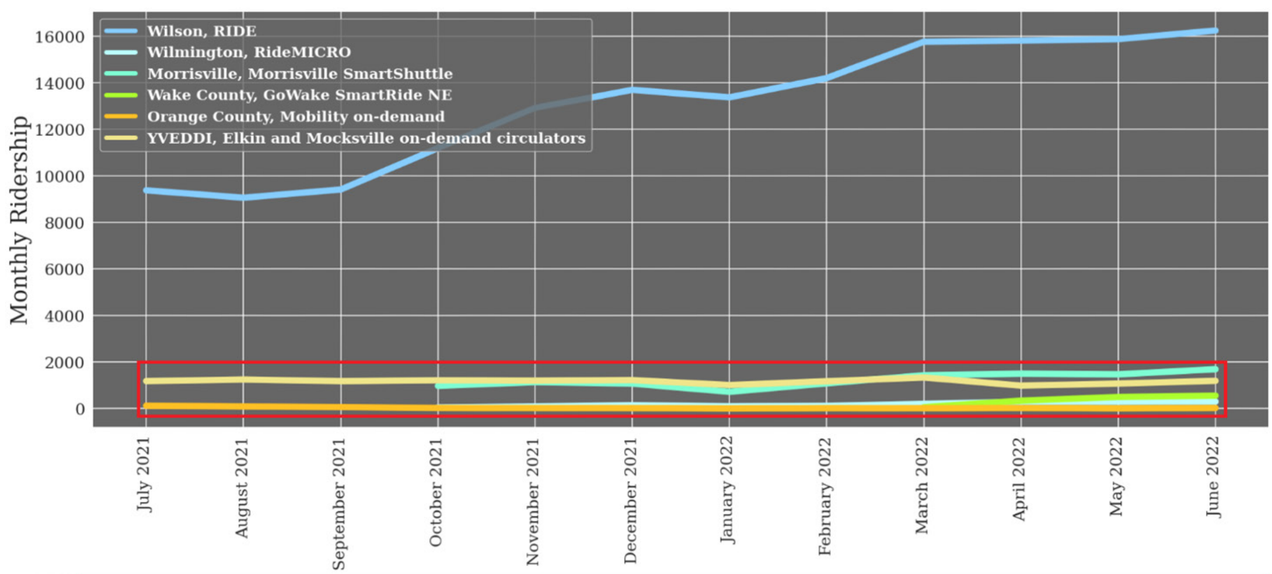
Microtransit systems	Wilson, RIDE	Wilmington, RideMICRO	Morrisville, Morrisville SmartShuttle	Wake County, GoWake SmartRide NE	Orange County, MOD	YVEDDI, Elkin and Mocksville microtransit
Service hours	Mon - Fri 5:30 AM - 7:00 PM, Sat 7:00 AM - 6:00 PM	Service hours differ by zone[a]	Mon - Fri 7:00 AM - 9:00 PM, Sat 8:00 AM - 8:00 PM, Sun 8:00 AM - 7:00 PM	Mon - Fri	Orange County Public Transportation	YVEDDI
Vehicle type	Branded vehicles with 6 seats	Branded vehicles with 10 seats	Branded vehicles with 16 seats	Branded vehicles with 12 seats	Branded vehicles with 4 seats	Branded vehicles with 12-15 seats
Fleet size	26	5	2	3	5	4
Wheelchair accessible vehicles	6	1 (shared across all 4 zones)	2	3	5	4
Fare ($/trip)	$2.50	$2	Free	Free	$5	$1
Payment	App, cash, or ticket books	App, cash, or ticket books	-	-	App only, no cash	Cash, passes, credit cards are not accepted
Trip scheduling (same for ADA trips)	App (Via), telephone or website	App (Moovit), telephone or website (at least 1 hour before the trip)	App (Via), telephone or website	App (Uber), telephone	App (TransLoc), telephone or website	App (CTS), telephone or website
Pre-schedule	Not available	Available up to one week in advance	Not available	Available up to 30 days in advance	Not available	Available up to 2 days in advance
Stop locations	Nearby intersections and major destinations	3000 fixed stops accessible by walking up to 500 ft. from every residence	16 stops with shelters	Door to door	Curb to curb	Door to door
Stop locations for ADA trips	Curb to curb	Door to door	Stop to stop; stops are wheelchair accessible	Door to door	Curb to curb	Door to door
Acceptable waiting time	15 minutes	30 minutes	15 minutes	30 minutes	15 minutes	15 minutes

a Zones 1 and 2: Mon - Fri 6:30 AM- 10:00 AM and 12:00 PM - 7:00 PM; Zones 3 and 4: Mon - Fri 6:00 AM - 8:00 PM, Sat 8:00 AM - 6:00 PM, Sun 9:00 AM - 5:00 PM.

b Drivers may call users and request them to travel a short distance to an accessible location in some cases.

7.3. Ridership

Figure 5 shows the change in ridership of the six microtransit systems in North Carolina. It is evident in Figure 5 that the RIDE in Wilson experienced remarkable increase in ridership over time relative to other microtransit sites. Specifically, the monthly ridership increased from 4,527 in September 2020 to 16,246 in June 2022. The service area of RideMICRO in Wilmington has a larger general population and also a larger transit dependent population. However, it has not experienced promising growth in ridership as expected by the transit agency. The microtransit projects in Wilson and Wilmington differ in terms of the purpose for which they are implemented. While the microtransit in Wilson was implemented as a replacement to a fixed route, the microtransit in Wilmington was primarily introduced as a feeder to the existing fixed route system in three service zones and to replace a fixed route bus service in one of the zones that already had low ridership. Hence, the difference in the service characteristics is not only affected by the service delivery models and the service provider but could also depend on the purpose for which microtransit projects are implemented. Nevertheless, according to the insights we gained from Wave Transit, the primary reason behind the stagnant ridership of RideMICRO can be attributed to inadequate marketing efforts. In terms of ridership growth, the microtransit in Wilson is the most successful microtransit implementation in North Carolina even though it has a relatively lower population density compared to some other sites.



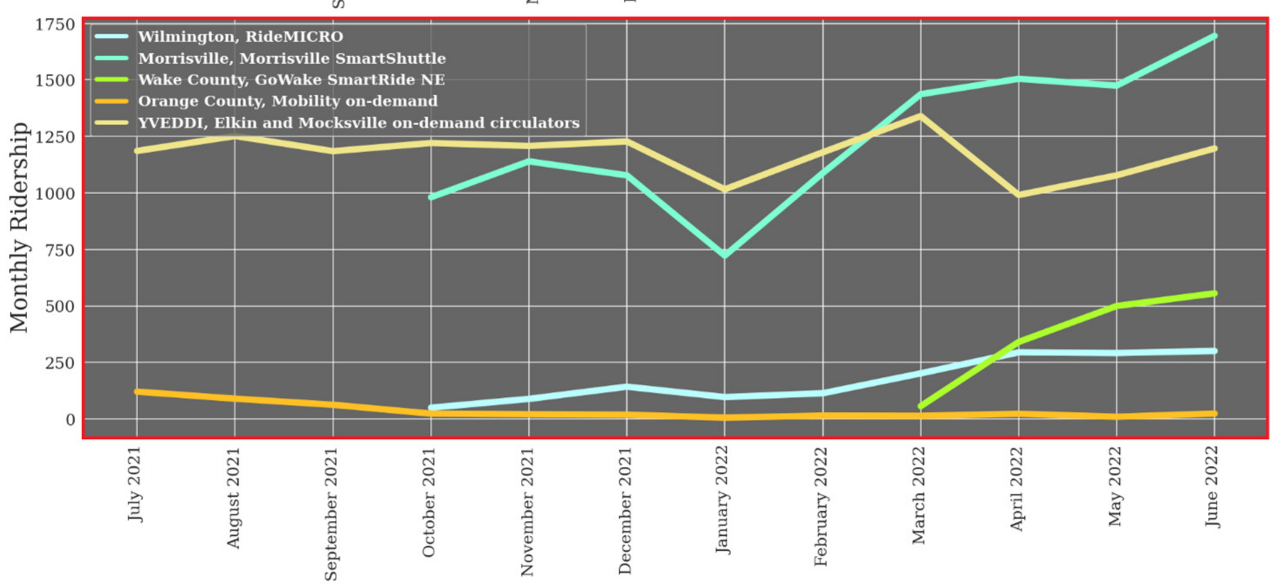


Figure 5 Ridership of microtransit projects

The microtransit in Morrisville has also mustered promising growth in ridership albeit not to the same level as that of Wilson. Nevertheless, it is important to note that the microtransit in Morrisville was implemented a year later than Wilson and with a significantly lower number of vehicles. Furthermore, even though Morrisville has a greater population density as compared to Wilson, Wilson had a considerably larger disadvantaged population compared to Morrisville. As shown in Figure 5, microtransit services started operation simultaneously in Morrisville and Wilmington, and both these services were implemented to serve as a connection to regional transit services. Although the service areas in Wilmington had a larger transit dependent population (zero-vehicle households, non-ambulatory population), the microtransit in Morrisville has a considerably higher ridership as compared to the microtransit service in Wilmington. GoWake SmartRide NE, implemented by Wake County, has a smaller ridership compared to Morrisville SmartShuttle. Figure 12 shows that the ridership of Morrisville SmartShuttle in the first month of its operation was 981 while the corresponding figure for GoWake SmartRide NE is 57. Nevertheless, the increasing trend of microtransit ridership in Wake County for a relatively smaller number of operating days indicates a growing demand for the service.

Given that Mobility On-Demand in Orange County is a microtransit service that operates on a temporal basis and has limited number of service hours, lower ridership in Orange County in comparison to other sites is reasonable. However, the decreasing trend in the ridership of the microtransit service is of concern. The ridership for the towns of Elkin and Mocksville are displayed as the ridership for YVEDDI in Figure 5. Since the microtransit service in both Elkin and Mocksville started operation in FY 2023, we do not have access to the ridership data. Figure 5 shows the ridership of the on-demand circulators for YVEDDI that operated before the microtransit system was initiated. The ridership of the on-demand circulators fluctuated between 1,000 and 1,300 passengers per month. The microtransit service has the potential to provide a better transit alternative to the residents of Elkin and Mocksville as compared to the on-demand circulator and further increase ridership by uncovering latent demand.

8. Capital and operational expenditures

We begin by exploring the contracts that public agencies formed with private providers to be able to operate a microtransit service. The contracts are discussed by service delivery model and the main information is summarized in Table 4. Expenditures related to technology appear in different forms, such as one-time setup and installation fees and monthly per vehicle fees. Vehicle and driver expenditures are typically charged based on an all-inclusive fixed rate per vehicle hour. The discussion of the contract costs is at the level of detail the written agreements allowed us to uncover. Direct cost comparisons are particularly challenging because of the different terms of each contract, such as the number of vehicles, vehicle size, vehicle hours of service assumed, whether the cost of fuel is included, and how fare revenue is handled. For these reasons, cost comparisons between microtransit systems should be applied with caution.

Microtransit vehicle, Wake County, NC

8.1. Turnkey service contracts

The City of Wilson formed a one-year turnkey contract with Via in June 2020 for a microtransit pilot. The contract was later amended for three years to support the operation of the system between September 2021 and August 2024. The contract includes a rate per vehicle hour ($38.27-$40.39), which primarily covers the cost of vehicles and drivers. This rate depends on the number of vehicle hours per week, meaning a higher rate per vehicle hour is charged if the vehicle hours per week fall below 700. A 2% increase in the rate per vehicle hour is incorporated for each year after the first year. The cost of technology and technical and operational support is covered through a fixed fee per service hour ($15). Via is also responsible for operating a dedicated phone line for phone reservations. The contract assumes 705 vehicle hours per week and 78.5 service hours per week, which implies approximately 9 vehicles in operation (the contract mentions 8-10 vehicles). The initial one-year contract for the pilot also included a $50,000 installation fee for the system deployment, but this was a one-time fee and was not included again in the three-year contract amendment. Via keeps the revenue from fares, and the contract states that "the total contract value outlined above is presented net of expected fare revenue collected."

In September 2021, Wave Transit entered a one-year turnkey contract with Bus.com for the RideMICRO microtransit pilot in Wilmington. The agreement contains a constant rate per vehicle hour ($70) which is inclusive of technology, vehicle, and driver costs. The contract outlines the responsibilities of Wave Transit, which include paying for fuel for the microtransit vehicles. The contract also outlines in detail the responsibilities of Bus.com related to driver training and alcohol and drug screening, vehicle preventive maintenance, inspections, safety, and cleaning, and reporting. Bus.com also operates a call center for phone reservations. Fares collected from the microtransit service are returned to Wave Transit.

8.2. Separate contracts for technology, drivers, or vehicles

In March 2021, Morrisville entered a five-year contract with Via for acquiring the technology for the Morrisville SmartShuttle. The contract includes a one-time installation fee ($29,000) as well as one-time device hardware and installation fees per vehicle ($380/vehicle). A monthly per vehicle fee is also charged, which sharply decreases with a higher number of operating vehicles. The contract includes an annual data plan fee per vehicle ($180/vehicle) for in-vehicle devices. A contract between the Town of Morrisville, the Town of Cary, and MV Transportation (the provider of Cary's transit service) was also formed for securing the vehicles and drivers for the microtransit operation. The contract only contains the rate per vehicle hour ($97.50), which reflects the operating cost for vehicles and drivers, including fuel and capital costs. The call center for the SmartShuttle is the GoTransit Regional Information Center, which is operated by GoTriangle, the regional transit agency of the Triangle Region.

In October 2021, Wake County formed a contract with Uber for one year for the technology to support the GoWake SmartRide NE microtransit. The contract includes a one-time setup fee ($25,000) as well as a one-time hardware installation fee for vehicles ($845/vehicle). The monthly fee for accessing the technology is $350 per vehicle per month. There is also an annual fee of $336 per vehicle for a 1GB monthly Verizon data plan for vehicles. Wake County also formed a contract with MV Transportation for the provision of vehicles and drivers. The contract provides the rate per vehicle hour ($42.53) that covers the cost of vehicles and drivers. In addition, the contract specifies that Wake County is responsible for the initial cost of branding the microtransit vehicles. The total contract cost is based on an estimate of 6,240 vehicles hours in a year.

8.3. Technology acquisition contracts

Orange County formed a one-year contract with TransLoc in November 2019 for providing the technology for the operation of the MOD microtransit service. The contract is comprised of a $25,000 fee which is inclusive of all technology-related costs during the pilot period (first six months) and a monthly per vehicle fee for the remaining six months of the contract. The monthly vehicle fee is lower for a higher number of microtransit vehicles in operation.

In May 2019, YVEDDI formed a one-year contract (with month-to-month automatic renewal thereafter) with CTS Software for CTS to provide the technology for the operation of the public transportation system throughout the four-county jurisdiction, which included demand response and on-demand circulators. The contract includes a one-time fee of $72,368 ($59,218 for software and license fees and $13,150 for installation, training, and other services) and a monthly fee of $1,883 for maintenance and support. In April 2022, the contract was amended to include the operation of the Elkin and Mocksville microtransit that replaced their on-demand circulators. The amendment includes a $5,295 one-time fee for software and installation and a $200 monthly fee. Because a large portion of the software and services charges from the initial contract did not have to be repeated for the microtransit service, the contract amendment costs presented in Table 4 are not representative of the full cost of the microtransit system. However, since it is not feasible to distinguish the portion of the original contract that would not apply to the microtransit service, we only present the cost items in the contract amendment.

Table 4 Contract cost information

	Wilson, RIDE	Wilmington, RideMICRO	Morrisville, Morrisville SmartShuttle	Wake County, GoWake SmartRide NE	Orange County, MOD	YVEDDI, Elkin and Mocksville microtransit
Start date	9/1/2021	10/1/2021	10/2/2021	3/21/2022	11/20/2019	7/1/2022
Technology provider	Via	Moovit	Via	Uber	Transloc	CTS Software
Vehicle and driver provider	Buggy	Bus.com	GoCary, MV Transportation	MV Transportation	Orange County	YVEDDI
Technology contract duration	3 years	1 year	5 years	1 year	1 year	1 year
Contracted fleet size	9	5	3	3	3	4
Total contract cost	Turnkey contract with Via: not to exceed $1,464,300 (in the 1st year)	Turnkey contract with Bus.com: $700,000	Contract with Via: not to exceed $142,280 Contract with Cary[a]	Contract with Uber: $42,493 Contract with MV Transportation: $265,379	Contract with Transloc: $34,000	Contract amendment with CTS Software: $7,695
One-time technology fees						
Installation and other technology fees	($50,000)[b]	-	$29,000	$25,000	$25,000[c]	$5,295
Device hardware and installation per vehicle	-	-	$380/vehicle ($1,140 in total)	$845/vehicle ($2,535 in total)	-	-
Annual technology fees						
Annual data plan	-	-	$180/vehicle ($540 in total)	$336/vehicle ($1,008 in total)	-	-
Monthly or hourly technology fees						
Fees/month	-	-	-	-	-	$200/month
Fees/vehicle/month	-	-	$384-$912/vehicle/ month[d]	$350/vehicle month	$300-$500/vehicle month[e]	-
Fees/service hour	$15/service hour	-	-	-	-	-
Call center operation						
Responsibility to operate call center	Via	Bus.com	GoTriangle	Wake County	Orange County	YVEDDI
Vehicle and drivers' cost						
Rate/vehicle revenue hour	min rate: $38.27; max rate: $40.39[f]	$70.00[g]	$97.50	$42.53	-	-

a The contract with the Town of Cary and MV Transportation does not include a total cost but only provides the hourly rate for vehicles and drivers ($97.50).

b This one-time fee was included in Wilson's first contact with Via (pilot phase) but not in the 3-year contract signed later.

c This one-time fee is for the pilot period and includes software license and support for the vehicles during that period.

d For vehicles 1-2: $912/vehicle/month; for vehicles 3-5: $480/vehicle/month; for vehicles 6+: $384/vehicle/month.

e The monthly fees are for software license and support during the post-pilot period. Vehicles 1-5: $500/vehicle/month; vehicles 6-10: $450/vehicle/month; vehicles 11-20: $400/vehicle/month; vehicles 21-30: $350/vehicle/month; vehicles 31+: $300/vehicle/month.

f The minimum rate per vehicle hour is applied if the weekly vehicle hours are below 700; otherwise, the maximum rate per vehicle hour is applied. These rates are for the 1st year of the contract, and a 2% increase in the rates is applied for future years.

g This rate per vehicle hour is inclusive of all costs (technology, vehicles, and drivers). Wave Transit pays the fuel consumed by all vehicles.

8.4. Operational expenditures

We additionally gathered the Fiscal Year (FY) 2022 Operating and Financial Statistics reports that the agencies operating public transportation systems need to submit to NCDOT at the end of each fiscal year. Until this last fiscal year, the public agencies were not required to submit these statistics separately for microtransit. The financial and service statistics for Orange County are not analyzed because they were submitted for their demand response and microtransit service in total and not separately. YVEDDI is also not included in this analysis because their system began operation at the end of FY 2022. The Operating and Financial Statistics reports include the number of operating days, ridership (total number of passengers), vehicle revenue hours and miles (hours and miles that vehicles travel while in service, which excludes training, maintenance, and travel to and from the dispatch point), and the total operating expenses (recurring costs of providing public transportation service, excluding planning and capital expenses). This information is used to calculate average costs per unit of travel, and the results are presented in Table 5.

An important metric for microtransit systems is the cost per passenger, which decreases as ridership increases. The microtransit system operating in Wilson has a very high cost per passenger ($246) due to its low ridership, despite being the service area with the highest population. For the remaining microtransit systems, the cost per passenger varies between $10 and $41. In comparison, the average cost per passenger for fixed route service (buses) is currently at $31.83 while the average cost per passenger for demand response service is currently at $54.66 (FTA, 2021). The calculated costs per vehicle revenue hour are relatively similar to the rates per vehicle revenue hour provided in the contracts in most cases. This is because the operating cost should not include capital expenditures, such as the one-time fees charged by the technology providers. However, because microtransit is an emerging public transportation mode, there is limited guidance on what should be included in the operational expenditure reports by public agencies. We therefore expect that there are inconsistencies among what is reported as a microtransit expenditure among different agencies. As an example, the operating cost submitted by Wilson for the fiscal year is substantially higher than the annual contract cost with Via. This is because the operating cost includes part of the salaries, fringes, training, and other costs related to the city staff associated with public transportation as well as the utilities and other costs associated with office space. Agencies that operate public transit services beyond microtransit may not include such costs in the microtransit operating costs but could be reporting them as part of their fixed route costs, for example.

Table 5 Operating cost and statistics

	Wilson, RIDE	Wilmington, RideMICRO	Morrisville, Morrisville SmartShuttle	Wake County, GoWake SmartRide NE
Fiscal year period	07/01/2021-06/30/2022	10/11/2021-06/30/2022	10/03/2021-06/30/2022	03/21/2022-06/30/2022
Operating cost	$1,609,052	$389,549	$425,940	$59,680
Operating days	313	185	271	74
Vehicle revenue hours	22,065	5,505	4,463	1,417
Vehicle revenue miles	315,409	17,333	54,626	16,542
Total ridership	156,887	1,583	11,122	1,454
Average monthly ridership	13,074	176	1,236	364
Latest monthly ridership (June 2022)	16,243	301	1,695	556
Cost per operating day	$5,141	$2,106	$1,572	$806
Cost per vehicle revenue hour	$72.92	$70.75	$95.43	$42.12
Cost per vehicle revenue mile	$5.10	$22.47	$7.80	$3.61
Cost per passenger	$10.26	$246.08	$38.30	$41.05

9. Preliminary analysis of microtransit customer satisfaction

The microtransit service provider in Wilson, Via, conducted a customer survey in the first two weeks of December 2021 to understand the level of user satisfaction, shortcomings in service delivery, and any unmet expectations that the users have from the service. The survey, distributed using the Via app, included 91 participants. However, not all questions in the survey had 91 responses as the participants of the survey could opt out from answering any question that either they did not have an answer for or if any question did not apply to them. Overall, the survey was structured to gather opinions from the app users about the value of the microtransit service in their daily life, the purpose for which they use microtransit, their opinion on what could be improved about the service, and to understand the sociodemographic profile of the users. The results of the survey are described in the following sections. It is important to note that riders who booked trips through the call center were not surveyed.

9.1. Value of the microtransit service

In this section, we present how valued the microtransit service is among the users. If people perceive that this service is indeed a contributor to their participation in civic life, it would be imperative to continue this service while enhancing any shortcomings in service delivery. As shown in Figure 6, 82.4% of the 91 respondents reported that the unavailability of RIDE would lead them to be disappointed. Following up on the reasons behind their disappointment in the event that they could not use RIDE, many respondents responded that RIDE was the only means of transportation in Wilson that they could afford.

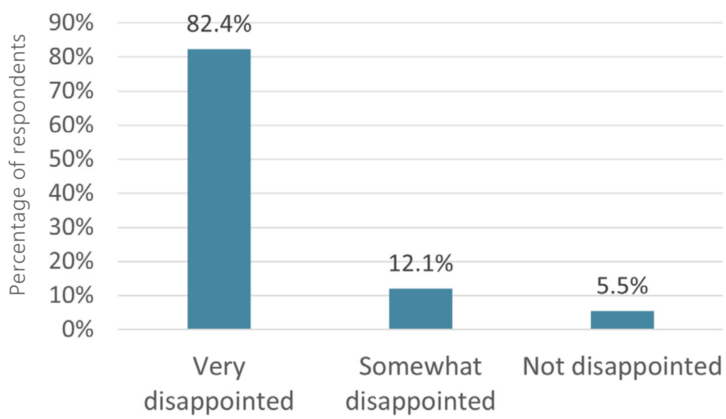


Figure 6 How disappointed would you be if you could no longer use RIDE?

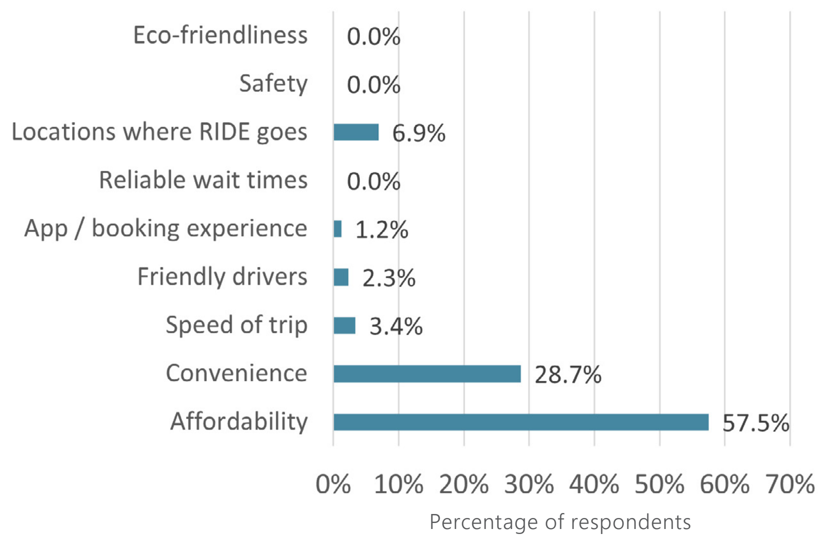


Figure 7 Why do you use RIDE?

Similarly, as shown in Figure 7, most respondents (57.5%) attribute affordability as the primary reason behind their use of the service. Saving money was selected by 77% of respondents as a benefit of the RIDE service. As one user responded, "I save money by paying $1.50 than paying $11.00 or $12.00 for a cab." Around 29% of respondents said that convenience was the reason that they use RIDE. Interestingly, around 7% of respondents said that the "locations where RIDE goes" is the reason they use the service. This indicates that the flexibility of RIDE to provide transit coverage to parts of the city that were previously underserved by transit has been beneficial to city residents. People in Wilson appear to value RIDE as a mobility service as compared to other available mobility services.

Many households (12%) in Wilson are zero-vehicle households. Perhaps relatedly, 48.4% of respondents said that RIDE has helped them increase their access to employment opportunities. RIDE provides an easy and affordable means to employment opportunities as one user articulated, "It's my main transportation to and from work. If not, I'd be left walking."

9.2 Purpose for which microtransit service is used

Figure 8 shows that most survey respondents use RIDE to travel to and from work. Similarly, 26% of respondents declared that running errands is the most frequent purpose for using RIDE. Around 14% of respondents use RIDE mostly for reasons associated with healthcare.

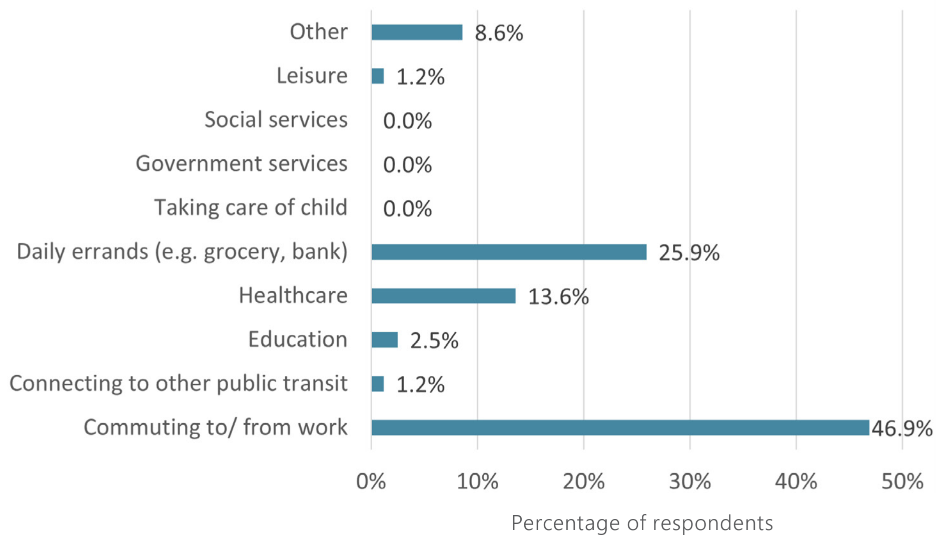


Figure 8 What is your most frequent use of RIDE?

9.3. Future improvements in the service

While the survey demonstrates that most users appreciate the microtransit service in Wilson, there are a few areas of service delivery that could be enhanced. For instance, as shown in Figure 9, 30.4% of respondents stated that waiting time is one aspect that requires improvement. Similarly, almost one-third of respondents would prefer the service hours to be expanded. Responses such as, "I have to be at work at 5am, service doesn't start until 7am" and "Sometimes I have waited 1 hr and a half to get home but I waited because I have no other option getting back and forth," clearly demonstrate that improvements are needed in the daily operation and scheduling of the microtransit trips. Figure 9 demonstrates the share of respondents with different opinions on the needed improvements.

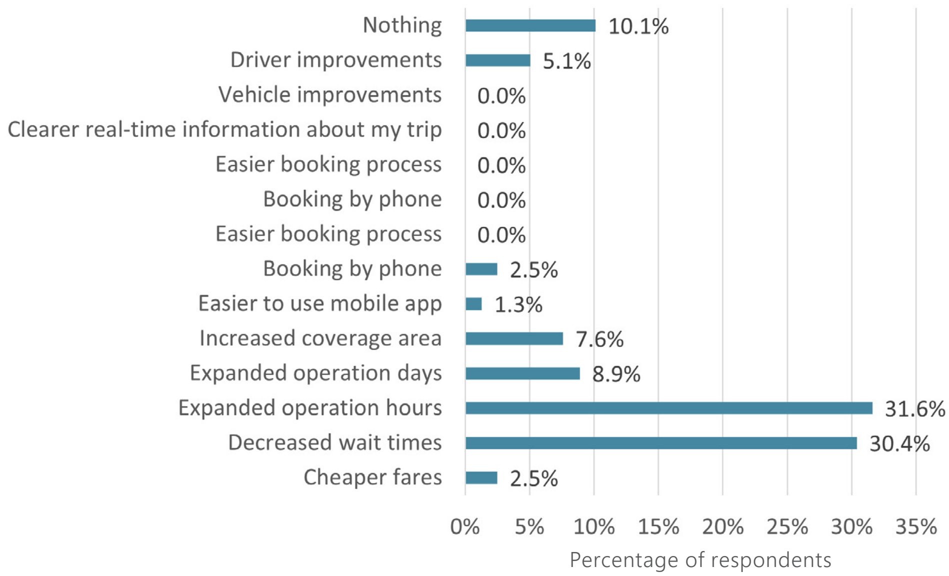


Figure 9 What would you like to see improved about the service?

9.4. Sociodemographic characteristics of respondents

Figure 10 shows that almost three fourths of respondents are women. Figure 11 highlights that only around 4% of respondents are Hispanic whereas 11% of people residing in Wilson are Hispanic according to the U.S. Census (U.S. Census Bureau, 2020). Interestingly, most respondents (52%) are employed either full-time or part-time. Around 10% of respondents said that they were not working, while 12.3% of respondents are retired individuals. Similarly, 86% of respondents said that they do not have a personal car to travel and participate in civic opportunities. Furthermore, while almost one fourth of respondents were not willing to provide income ranges, 57% of respondents earn less than $25,000 per year. One in ten respondents (11%) have a mobility impairment and 3.7% of respondents have mental health conditions. The majority of respondents (61.3%) reported their race as Black or African American while, according to the U.S. Census Bureau (2020), around 48% of the population residing in the service area is Black or African American. The sociodemographic characteristics of respondents indicate that RIDE has provided significant mobility benefits to people who would be traditionally defined as transportation disadvantaged. RIDE is seen as a valuable means of mobility by the residents of Wilson. However, RIDE needs improvements to increase its attractiveness and coverage.

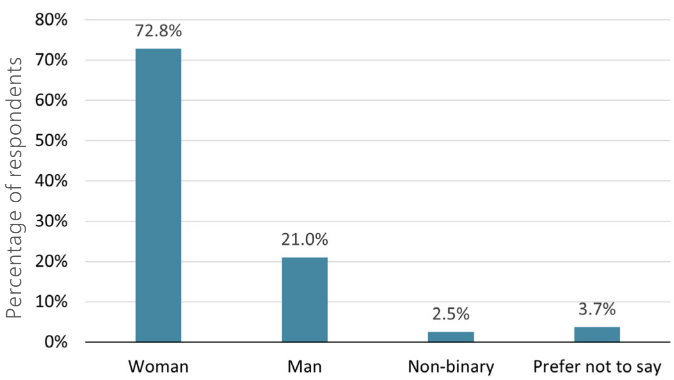


Figure 10 Gender

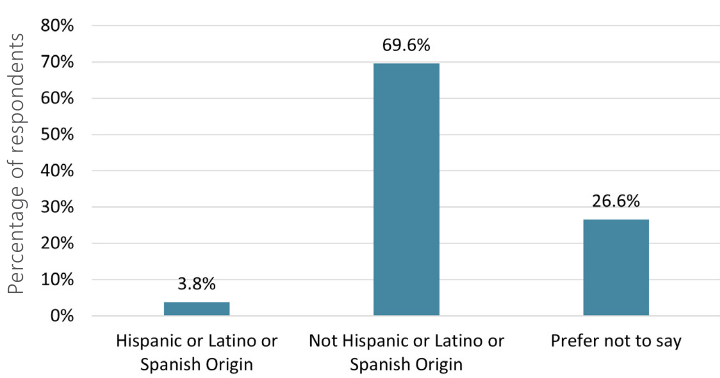


Figure 11 Ethnicity

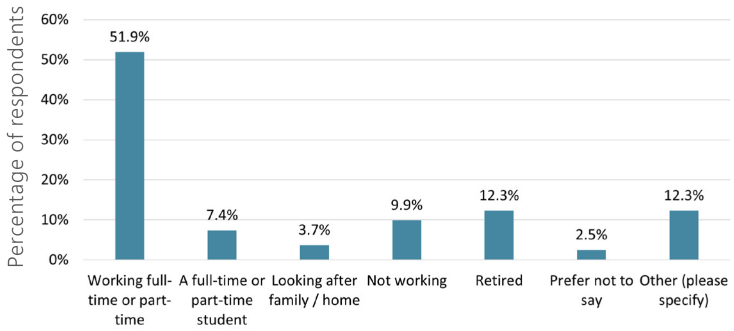


Figure 12 Employment status

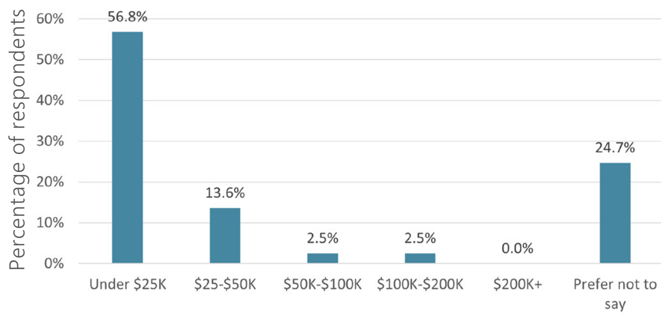


Figure 13 Income distribution

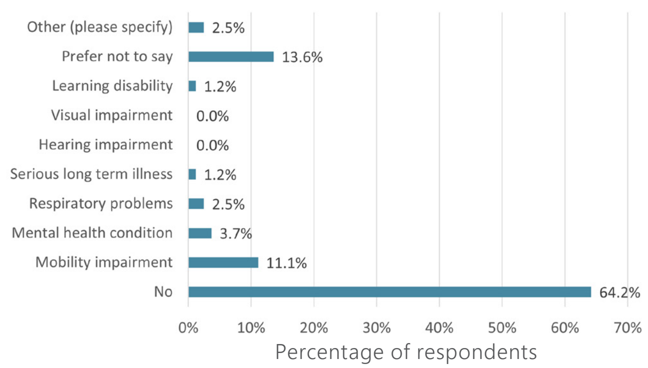


Figure 14 Physical or mental disabilities that affect travel

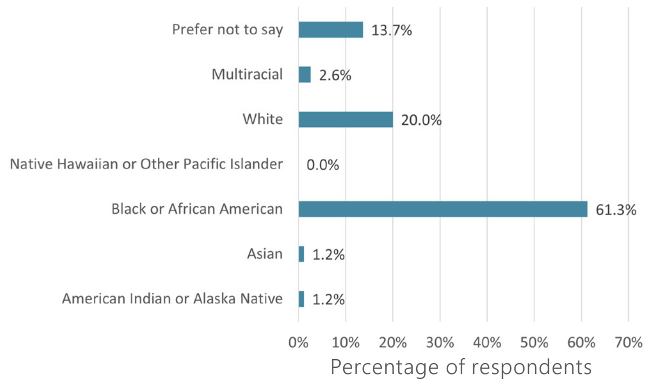


Figure 15 Race of the users

10. Planning and implementation challenges

The representatives from the public agencies that we interviewed conveyed overwhelming satisfaction among users towards microtransit service that allows them the flexibility to request a trip when needed. Nevertheless, complaints were reported by users primarily regarding service operations that could require attention from the administrative agencies. As an emerging mode, microtransit implementations may not easily and adequately address all federal and state compliance requirements. For instance, operator training, drug screening, cash management, and reasonable suspicion evaluations may be more difficult to conduct when operators are independent contractors, particularly in the case of turnkey operations and operations that put separate contracts in place. Vehicle maintenance and safety checks may also raise similar concerns. Compliance with the Americans with Disabilities Act (ADA) is a common thread throughout many of the equity concerns. This section is a summary of challenges identified from interview data, user feedback, and information from contracts. With respect to the existing challenges, we found the main issues that the agencies encountered that may decrease user satisfaction towards the service and also impose difficulty on the operation or extension of the project. Some of the challenges are common across different microtransit implementations regardless of the purpose of implementation and the service delivery models. Others could be specific to a contract type. We discuss the challenges specific to a service delivery model whenever appropriate. In addition, based on the information collected from interviews and the customer survey, we present some of the compliance and equity related issues associated with the implementation of microtransit.

Microtransit vehicle, Orange County, NC

10.1. Availability of funding

Most public transportation is funded at least in part by the Federal Transit Administration (FTA), either directly or through State Departments of Transportation or Metropolitan Planning Organizations (MPOs). At each funding level, formulas are often used to inform funding amounts. Many formulas begin with statistics from the National Transit Database (NTD), which requires all reported statistics to be related to the provision of public transportation (FHWA, 2022). Among other criteria, to qualify as public transportation, the services must be open to the general public or a segment of the general public, be capable of providing shared rides, and be delivered on vehicles branded as public transportation (Shaheen & Cohen, 2018). **Even if the public transportation definition is met, microtransit services are currently included as a demand response mode in the NTD. Some funding formulas may provide lower levels of funding for demand response versus fixed route modes.** As an example, North Carolina's State Maintenance Assistance Program (SMAP) allocates funds based solely on fixed route statistics. Meanwhile, an MPO formula may ascribe a higher dollar amount per unit of service for fixed routes compared to demand response or microtransit. Agencies like the City of Wilson and YVEDDI that replaced fixed route transit may potentially experience a loss in funding for public transportation. In other words, **this challenge of loss in funding could be most prominently faced by agencies implementing microtransit as a replacement to fixed route service.**

Unavailability of sustained funding is a challenge that most agencies face, particularly those that receive funding as a grant for conducting a pilot project. Most microtransit systems considered in this study were first implemented as pilot projects partially funded by either year-long federal grants such as the Accelerated Innovation Mobility (AIM) grant and the Integrated Mobility Innovation (IMI) grant (49 U.S.C. § 5312 - Public Transportation Innovation, 2015) or state funds such as Consolidation and Coordination of Public Transportation services (ConCPT) and Rural Operating Assistance Program (ROAP) (ConCPT Program, 2021; Rural Operating Assistance Program (ROAP), 2020).

FTA's AIM grant attempts to encourage innovative transit technologies and practices to advance the state of practice for public transportation in the U.S. An important objective of the AIM grant is to identify, test, and share new approaches for the transit service delivery models. The IMI grant enables local governments and communities to incorporate three innovative mobility options with the existing services and it primarily focuses on three areas: i. Mobility on-demand, ii. Transit automation, and iii. Mobility payment integration. One of the primary objectives of an IMI grant is to assist transit agencies to develop the ability to integrate the aforementioned innovations into their existing public transit service. On the other hand, state ConCPT grants aim to assist public transit service providers to integrate two or more transit services in a region into a single transit system to enhance the efficiency of transit operation. Agencies in NC that are eligible to be recipients of FTA funds or subrecipients of FTA funds through NCDOT the Integrated Mobility Division (IMD) are eligible to apply for a ConCPT grant.

ROAP is administered by NCDOT IMD to assist county governments and regional public transportation agencies to help their elderly and disadvantaged populations access employment, health, and other important destinations. All counties in NC are eligible recipients of formula-based allocation of ROAP funding. ROAP formulas include factors like proportion of unemployed, disabled, senior residents, and rural populations in a county in addition to the costs incurred for providing public transportation trips. While transit agencies that qualify for the grants may reapply, or in some cases receive funds continuously based on formulas such as ROAP, the availability of these funds is not always ensured. The agencies we interviewed informed us that they might have to find other funding sources themselves after grants expire or when discretionary and formula funds are unavailable. If appropriate funding is limited, they might not be able to provide the microtransit service as expected. For instance, the interviewee from YVEDDI informed us about their concerns about the continuity of funding from ROAP in the future. Similarly, the ConCPT grant used to operate the microtransit pilot in Wilmington is a year-long grant and upon the expiration of the grant, the microtransit service in Wilmington would be limited to only two of the four zones. The lack of mechanisms to provide sustained funding in combination with the high cost associated with microtransit operation poses a significant challenge to transit agencies.

Microtransit vehicle, Wake County, NC

10.2. Cost of operation

Another issue that the existing literature identifies about microtransit is the high cost of operation (Currie & Fournier, 2020; Jokinen et al., 2019) that requires the transit agency to heavily subsidize it as a transit service irrespective of the service delivery mechanism or the purpose of implementation. Further, unlike fixed routes that do not experience significant changes in expenses with increase in ridership, the costs of operating microtransit may vary significantly over time as the demand increases. As microtransit increases in popularity, additional operators and vehicles need to be provided to maintain the attractiveness of the service. Buses can be chosen to meet peak demand, while the marginal costs of increased microtransit ridership can be more substantial. Hence, transit agencies would further require additional resources to continue the microtransit service as it unveils the latent mobility demand. Securing funding from state and federal formulas in an environment wherein significant variation in operational characteristics could be experienced is also a challenge common across all transit agencies.

10.3. Meeting the demand

User complaints about limited service hours and long waiting times are relatively common across the microtransit systems we studied. One of the primary reasons for high waiting times and restricted service hours is the funding constraints that the agencies operate under. The amount of funding available typically governs the operation hours, the fleet size, and the number of drivers. **The high cost of operation does not allow the public agencies to expand the service hours to evenings and weekends**, when some low-income individuals need to get to work, even though the microtransit service is often the only feasible mobility option in that area.

Some agencies also reported that during peak periods, waiting times increase substantially and some trip requests cannot be accommodated (users are not able to book a ride). Whereas a fixed route may have enough seating capacity to handle peak demand, the microtransit model requires different types of solutions. TNCs use surge pricing to manage supply and demand. However, microtransit systems, which seek to serve transportation disadvantaged populations, have constant, low fares. In addition, the public agencies have found it difficult to attract operators to go into service for short shifts to add capacity to the system during peak periods.

One of the underlying reasons behind the long waiting times is the **low proportion of rides that are being shared with other bookings**. The interviews with the public agencies revealed that the microtransit vehicles are largely underutilized. For example, in the case of Wilson and Wilmington, more than 60% of trips include a single passenger only. The optimization algorithms currently at use in practice and the high proportion of on-demand (versus pre-scheduled) trips have not encouraged shared rides. Some of the public agencies we interviewed have expressed these concerns to the technology providers and are presently trying to identify solutions. The ability for microtransit to efficiently serve customers during peak hours should be a concern for transit agencies that either seek to replace a fixed route or if they plan to implement a new transit service in a low-density area. Fundamental research in demand management and ridesharing for microtransit systems is needed to provide solutions to these challenges. If microtransit is implemented to serve as a connector to a regional transit center, the transit agency and the involved partners should ensure that the microtransit is synchronous to the operation of the regional transit service. Implementing a synchronous multi-modal technology platform, whereby users could book the full trip from their origin to destination even though it would require multiple transfers, is a challenge to both public and private partners and has not been accomplished in practice in the systems we studied.

Microtransit vehicle, Wake County, NC

10.4. ADA compliance

One of the main motivations behind providing microtransit service is to provide access to people who are transportation disadvantaged such as low-income, carless, and disabled individuals. However, microtransit services are heavily dependent on algorithms that could emphasize operational efficiency rather than providing an equitable means of mobility for disadvantaged populations especially if communities or individuals are geographically isolated.

The Americans with Disabilities Act (ADA) guarantees the right to equivalent services regardless of a person's disability status. Almost all fixed route, paratransit, and demand response public transportation vehicles in North Carolina are ADA compliant. If someone lives within 3/4 miles of a fixed route and cannot access a stop because of a disability, they are offered complementary paratransit services (NCDOT, 2012). Most of the clientele of demand response transit in North Carolina has some form of mobility impairment.

If microtransit is implemented as a replacement to a fixed route service, the requirement for complementary ADA paratransit is also removed. However, public **microtransit systems must offer equivalent service to persons with disabilities, and all public transportation systems must monitor for ADA equivalency** (NCDOT, 2012) . This requirement takes special importance where scheduling for non-ADA trips would follow a different process than for ADA trips. Some microtransit services have limited ADA certified operators and **limited numbers of ADA compliant vehicles**, because of the extra investment for vehicles and special operator certification combined with the inability of some microtransit software to incorporate ADA accessible service and other ADA needs. In addition, some contracted microtransit service providers may not have as much training as public transportation operators and therefore may not be aware of the civil rights requirements of the ADA.

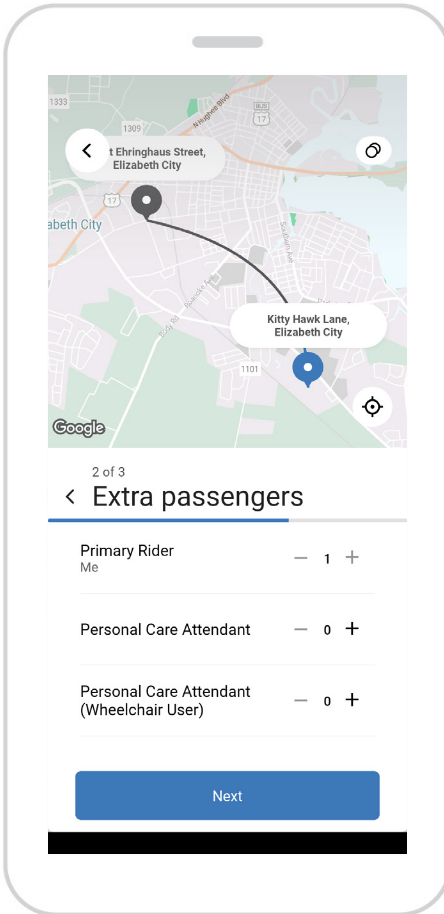
10.5. Declaration of ADA status

In some microtransit implementations, users can self-declare their disability status when they set up their user profiles in the app. Although self-declaration may be an easier way to identify users that require ADA considerations from the start, this practice will likely be problematic as the system matures. The ADA is a civil right that applies to protected status individuals. Self-declaration can saturate the service with persons claiming ADA status and thereby receiving special treatment (such as door-to-door service) when it does not apply to them. If these false claims adversely impact people with verifiable ADA status with increased waiting time and delayed pickups, the transit system would be violating the law. Addressing such concerns is a significant challenge to the operators of a microtransit system.

10.6. Banking and technology related barriers

Because of the heavy emphasis on apps and technology, microtransit may be inaccessible to those without strong technology skills, access to the internet, or access to mobile data devices. These potential users mostly include people in poverty, children, the elderly, and people with cognitive disabilities, i.e., communities that often suffer from transportation disadvantage and may have the most need of microtransit. In addition, some **service providers operate with the policy that the users need to link their bank/card details to the mobile application** in order to request a trip even though the rides may be free to the user. Having a phone option where people can call an agent and request a trip and have the agent provide equivalent updates on the trip status can overcome some of these barriers.

The relatively **high number of trips scheduled by phone** and not through the mobile application at some of the study locations provides some evidence that a substantial number of people in the service areas considered in this study may not be comfortable using a smartphone application or are only able to pay in cash. Specifically, based on the information provided by the interviewees, most trips were requested by making a call in Wilmington, 17% of trips in Wilson were requested by making a call, and only 3 trip requests were made using the Uber app in the first 90 days of service in Wake County. Finding technology providers that can offer flexible payment options to address the needs of a disadvantaged community remains a challenge for equitable microtransit service.



App screenshot, Elizabeth City, NC

To provide users the option to a request ride by making a phone call, microtransit systems operate a call-center. Among the microtransit systems we study, the entity responsible for operating the call center vary with the service delivery models adopted. For instance, in Wilson and Wilmington where a turnkey model of service delivery is adopted, the technology providers are entrusted to operate a call center to book rides for the users. On the other hand, for microtransit systems where separate contracts are put in place, call centers are the responsibility of the public agency and could be merged with an existing call center offered by a public agency in that area. Some service providers are not flexible with providing additional services like operating a call center or tailoring the scheduling software to the requirements of the transit agency. Requiring the service providers to operate a call center to provide a telephone option to request a trip under a turnkey contract or separate contracts may come across as a challenge to some transit agencies with some service providers.

10.7. Virtual stops and access to vehicles

There are three basic stop types in public transportation: i. door to door, ii. curb to curb, and iii. stop to stop. Microtransit introduces a fourth type of stop often labeled as “virtual stops.” The virtual stops are driven by algorithms unique to each microtransit software and are designed to improve operational efficiency with regards to alleviating the waiting time while increasing the number of passengers served per hour. Unlike the door-to-door services provided by ADA paratransit or the curb-to-curb services provided by the TNCs, a user requests a ride from a specific location (A) to another specific location (D), but is informed by the algorithm that they are required to access the vehicle at location (B) which drops them off at another location (C). In some systems, the virtual stops are predetermined (e.g., Wilmington has 3,000 virtual stops), while in others (e.g., Wilson), all intersections could serve as a virtual stop. This practice requires the users to walk a certain distance from their location to access the service and creates difficulty for some users in certain circumstances. The interviews revealed that the algorithms are currently ignorant of the local traffic and pedestrian infrastructure and often **request users to walk across unsafe conditions such as heavy traffic and unmarked/unsignalized crosswalks**. Unlike the stops in a fixed route system which are generally assessed for safety by transportation professionals, the virtual stops are generated by algorithms and technology providers who may have never made an in-person visit in the service area. It is therefore common for the trip scheduling software to **require the users to wait in unexpected or unsafe locations**. Further, the interviewees shared complaints from riders who use the microtransit service for errands such as grocery shopping and are often required to walk to an intersection or a node to access the vehicles while carrying their groceries. The issues of safety and the difficulty of accessing vehicles have been found to be a common challenge across different microtransit implementations. Some of the interviewees also mentioned that the drivers do not always follow the software instructions in an effort to avoid risky conditions for the users. For example, if a driver assesses that a drop-off point instructed by the software is not safe, they will drop off the users in a safer location or crossing. However, the software will not allow them to mark the ride as complete unless they get to the initial drop-off location, so the drivers still have to drive to that location, increasing the waiting time for upcoming trips.

Wilson, NC

Finding the right equilibrium in the trade-off between convenience to the users and the efficiency of service is a challenge for microtransit projects. Public agencies that maintain a higher level of control and involvement in the microtransit system may have a higher probability to offer safe and convenient virtual stop locations to the users compared to turnkey operations. In every case, public agencies should collaborate with the technology provider in the development and assessment of the virtual stops and incorporate intelligence and flexibility in the algorithms to switch to door-to-door or curb-to-curb service to accommodate special circumstances (e.g., grocery store pickups, adverse weather conditions) and individuals with disabilities.

With regards to ADA trips, some microtransit systems provide a door-to-door service while others only provide curb-to-curb service. For instance, microtransit services in Wake County and YVEDDI provide door-to-door service for ADA trips. In Wilmington, pick up and drop off for the regular microtransit trips take place at designated stops but door-to-door services are provided for ADA trips. The microtransit system in Wilson on the other hand only provides curb-to-curb service for trips requesting ADA compliance. Although each node in Morrisville is ADA accessible, the microtransit requires individuals to wait at the designated stops. The unavailability of door-to-door service could present a challenge of access for some users with medical conditions that make it difficult for them to access the stops or the microtransit vehicles.

10.8. On-demand versus pre-scheduled trips

A fixed route rider makes no reservation, an ADA paratransit rider has until the day before to make reservations, and the reservation cut-off for a demand response rider depends on local policies and may be one or more days before the trip occurs. Microtransit requires the user to request a trip through a smartphone application, website, or call center, and has the ability to process trip requests on demand (in other words, as soon as possible). The user's waiting time, the time between the on-demand trip request and the actual pick-up time, is affected by contemporaneous service demand and supply-side constraints. Waiting times and the goals that the agencies have set for waiting times (acceptable waiting time, shown in Table 3) vary by system.

Some microtransit implementations adopt a **strictly on-demand** approach to trip scheduling, meaning that the users do not have the flexibility to request a trip hours or days in advance of their required schedule. This characteristic of microtransit service is **unfavorable to time-sensitive and critical transportation needs such as work-related commute or medical appointments**. Based on the information provided from public agencies operating strictly on-demand systems, when demand is high, for example during the morning peak period, users may face higher waiting times and delays. A small proportion of the users may not even be able to secure a ride during periods of high demand – they may receive a message that the system cannot accommodate any more trip or their upcoming trip may get canceled. This can be highly problematic for critical trips and disadvantaged populations fully relying on the microtransit service for such trips. In addition, special needs populations, such as those attending adult daycare workshops, are often pattern-reliant and may not have the ability to request their own transportation or adapt to the unpredictability of different times, delays, and different pick-up locations. Although the ability to accommodate on-demand trip requests is very important, there is also a significant segment of the population that requires pre-scheduled, reliable transportation. The agencies that are operating strictly on-demand systems have been becoming more and more aware of these challenges and have initiated discussions with the technology providers to identify solutions to address these concerns of the special needs and time-sensitive populations. Microtransit implemented as a replacement to a fixed route or demand response service in an area that has a considerable proportion of clientele that needs pre-scheduled transportation may not be a reliable means of mobility if pre-scheduling of trips is not an option.

10.9. Driver shortage and training

Driver shortage is surfacing as a challenge to many transit agencies across the country (Woodhouse, 2022), and it also applies to the sites discussed in this study, particularly as it takes multiple vans to achieve the capacity of a single bus. Competition from other private-sector, higher-paying jobs that require less in-person interaction, rise in crime against drivers, and unemployment benefits have been explained to be the reasons behind the bus driver shortage (Tse et al., 2006; Woodhouse, 2022). Representatives of some of the agencies that we interviewed expressed the concern that driver shortage could be a challenge for smooth operation of microtransit in the future. Driver shortage would have ramifications on the daily operation and scheduling of the microtransit service and could result in longer waiting time for the users.

Another important issue that planning agencies and service providers must address is adequate training of the drivers. Indeed, in some cases, users have complained that some of the drivers are rude and smoke in the vehicles. Moreover, since the operation of microtransit heavily depends on the use of a digital interface by the driver and not all drivers may be tech savvy, it is important to train the drivers regarding the use of the digital interface used by the microtransit system. For instance, some microtransit systems (GoWake Smart RideNE and RideMICRO) allow the driver to accept or reject a trip request. The transit agency should attempt to provide guidelines to the drivers regarding the conditions in which they

Microtransit driver, Wilmington, NC

are allowed to deny a trip request. While training the drivers is important to provide the users with a satisfactory experience when using the service, planning agencies face the challenge of already limited number of drivers. Further, transit agencies that adopt a turkey model or separate contracts to provide drivers for day-to-day service operation have limited control over the availability and the demeanor of the drivers. Another challenge that transit agencies face when implementing microtransit are the drug testing requirements for drivers, especially for turnkey operations. Federal law (49 CFR Part 655) requires transit agencies or any contractor (sub-contractor) that operates a transit service funded by FTA to implement and maintain an FTA-compliant drug and alcohol program (FTA, 2022). Some microtransit projects are implemented using state or local funds, a strategy that may be employed to avoid FTA drug and alcohol regulations.

10.10. Data ownership

Continuous assessment of the operational characteristics is crucial for the planning agency to better understand the performance of the microtransit service and to make informed future plans on the required fleet size, operation hours, and marketing techniques. Awareness about the spatiotemporal differences in transit demand is essential for the service to dynamically adjust to the changing demand. Moreover, it would be in the interest of the planning agencies to either self-assess or collaborate with academic institutions to study the operational characteristics of the service and analyze if the service is delivering expected mobility as well as accessibility outcomes.

However, **unless explicitly specified in the contract, it is generally the technology provider who owns the microdata** (data on individual trips) and the agency can only access the data that is provided to them by the technology provider in the form of weekly or monthly reports. The experience from Morrisville shows that the ownership of the data depends more on the contract negotiation process itself rather than the service delivery model or the service provider selected. While both Wake County and Morrisville adopted separate contracts to operate microtransit, the Town of Morrisville owns the trip-level data while Wake County does not have the ownership of the data. Similarly, though both Morrisville and Wilson have the same service provider, the Town of Morrisville owns the trip level data but the ownership of data in Wilson lies with the service provider. If the agencies do not own the data themselves or do not require (in the contract) that the technology provider makes the data available, the agencies might face difficulty in assessing the service and facilitating research. Moreover, agreements with the technology providers on making the data transparent and accessible may entail a long and complex litigation process. This would discourage research and ultimately hinder the improvement of the service. Hence, agencies that depend on technology providers for service delivery could face the challenge of data ownership and data sharing with other partner agencies.

11. Lessons learned

This section summarizes the experiences public agencies shared regarding microtransit planning and implementation, and other important information from the terms and conditions outlined in the contracts and the operational statistics that the transit agencies submitted to NCDOT. This section presents the insights that the planning agencies considering microtransit service need to consider to make their planning and operational process resilient, user friendly, and equitable.

The first insight captured from our interviews is that microtransit is one of the best possible ways to provide transit access in areas with low population density and in small service areas. The interviewees generally agreed that microtransit is valuable because it can increase community mobility and uncover latent demand, meaning trips that would have been taken if a convenient, affordable transportation option were available. Identifying the latent demand for trip-taking is essential for creating a healthy and sustainable economy because it creates opportunities for marginalized populations to participate in civic life regardless of their sociodemographic background and geographical location of residence. This opportunity is especially important and can provide growth opportunities in marginalized and emerging communities.

11.1. Need for feasibility studies

The framework within which a microtransit service operates should be contextual to the requirements of the population and the geographical area under consideration (Zuniga-Garcia et al., 2022). Therefore, while it is important to explore the experience of peer agencies, the planning agency that wishes to implement microtransit should perform a careful analysis of market demand, travel patterns, preferences of its residents, and funding availability. Developing a comprehensive framework to implement the microtransit service is important. For instance, agencies that invested resources in conducting feasibility studies to determine the most appropriate transit solution for their jurisdiction have been able to smoothly implement microtransit services based on the guidelines of the study. The feasibility studies typically assess the existing transportation inventories and the need of public transportation improvements in the area to meet the goals and visions set by on the comprehensive transportation and land-use plans of the local governments (North Carolina General Statute 160 D requires local governments to adopt and maintain land use plans to enforce zoning regulations in accordance to the vision of the comprehensive plan (NC G.S. 160D, 2022)). Further, the feasibility studies recommend the type of on-demand transit suitable for the service area based on the identification of factors driving potential public transportation demand such as location of employment centers, location of important destinations (airports, downtown), land use, existing travel patterns, and population distribution. Finally, based on the holistic assessment of travel patterns, sociodemographics, built environment condition as well as the financial constraints of the transit agency, a feasibility study should recommend the location of microtransit stops, fleet size, and the service delivery methods in detail. Having a well-researched plan helps the transit agency implement the microtransit service in a resilient manner.

11.2. Funding sources

To address the needs of people with the greatest mobility need, emerging and rural communities in North Carolina already receive federal and state transportation funds. Reallocating existing funding from other coordinated demand response transportation to microtransit risks reducing access for existing riders, hindering their ability to obtain essential mobility services. Given limited existing funding and the requirement that the needs of existing riders are met, the best approach for implementing microtransit is to establish new funding at the federal or state levels. Meanwhile, in addition to the funding required for starting the service, agencies also need to explore additional funding for service expansion and improvement. While fixed route services can address increasing demand with the same number of vehicles, additional vehicles would be required in microtransit systems to meet demand. For instance, our analysis of ridership data for RIDE showed that monthly ridership in Wilson stalled between April 2021 and September 2021. The interviewee from Wilson informed us that the stall in ridership was because the microtransit service was unable to meet the increasing demand with the existing fleet size. The interviewee also informed us that they added vehicles to their existing fleet in September 2021. After additional vehicles were introduced to the service, monthly ridership again started increasing. To expand service delivery, the agencies need more investment. Diversifying the funding sources when attempting to ensure sustained funding could be a successful long-term strategy with regards to the smooth and efficient implementation of microtransit.

11.3. Inclusive decision-making

The decision-making process should involve multiple stakeholders from the beginning of the planning phase. Our interviews and customer survey suggest that support from the public as well as private entities is vital to the success of the project. Indeed, collaboration with varied stakeholders, including employers in the service area, would not only be beneficial in exploring funding opportunities but also help in establishing the initial user base necessary for the success of the project. In addition, partnering with community-based organizations is important to bring into perspective the needs and constraints related to disadvantaged users who need the microtransit service. For example, **individuals living in shelters, such as victims of domestic violence, may not have access to electronic payment options**. Public agencies that prefer not to offer a cash payment option should work with the technology providers to accommodate the most vulnerable users. Working with multiple stakeholders and jurisdictions may be a challenging and time-consuming process, but can lead to a more equitable service.

11.4. Selection of service delivery model

Selection of a service delivery model is an important planning decision with regards to the implementation of microtransit. The selection of the service model for a microtransit system may depend on the resources available at the agency and their previous experience of operating a transit service. We note that there is a host of literature concerning the advantages and disadvantages of outsourcing in the public sector, primarily based on how much direct control of operations the agency desires or is capable of (Patel, 2017; Rème-Harnay, 2022). We summarize the relative advantages and disadvantages of each service delivery model in Table 6. We note that for all three models of service delivery, it is the responsibility of the public agency to ensure that equivalent service is provided for those who qualify for ADA transportation.

Table 6 Benefits and challenges of different service models of microtransit

Service model	Advantages	Potential challenges
Turnkey	The public agency does not need to own vehicles, employ drivers, and coordinate the daily operation of the microtransit service. A single point of contact could make it easier for the public agency to resolve issues and concerns.	The public agency has limited control over the quality of service delivery such as driver training, drug screening, vehicle maintenance, and safety. Replacing the service provider may have significant impacts on service delivery.
Separate contracts for software, drivers or vehicles with different entities	The public agency does not need to own vehicles or employ drivers to operate the microtransit service.	Multiple contracts leave the public agency in charge of coordination and communication between the different providers, which could be especially challenging when issues arise (e.g., a road accident).
Technology acquisition	The public agency has control over daily operation, vehicle inspection and maintenance, drug screening, and other service delivery processes.	The public agency implementing the microtransit may need to purchase their own vehicles and hire drivers. The cost of the service may substantially increase if the drivers are public employees. Short shifts may not be an option if the drivers are public employees.

Different methods of service delivery have different relative advantages. The planning agency should explore the option that is most suitable to them considering the advantages and the challenges that we present in this study. For instance, it would be appropriate to adopt a turnkey model for service delivery if the agency does not have any prior experience with operation of flexible transit service and if it lacks ample human resources to operate the service. On the other hand, if an established service provider is already operating some form of demand response transportation in the area, it could be a judicious decision to adopt a technology acquisition model or have separate contracts with different agencies for the software and driver/vehicles. The selection of the service delivery model should primarily be governed by the requirements of the service areas and transit agency. The selection of the service delivery model is also influenced by funding constraints. Agencies need to carefully select a service delivery model that fits within their budgetary constraints and also meets their needs. For instance, agencies that wish to implement microtransit under significant budgetary constraints may consider technology acquisition as a suitable means of service delivery if they operate fixed route services or some form of on-demand transit services in-house, particularly if they have a pool of drivers already employed by the transit agency. However, this mechanism would not be suitable if the agency does not own vehicles or have in-house drivers because capital expenditures such as purchasing new vehicles and hiring new drivers could be even more expensive in the short run than adopting a turnkey model. The public agencies we interviewed also expressed that they considered the relative advantages of the service delivery models while selecting their service delivery model. On one hand, planners in Wilson adopted a turnkey contract because of the risks associated with capital expenses (vehicles and drivers) while implementing a microtransit pilot project. On the other hand, planners in YVEDDI adopted a technology acquisition model because the transit agency already had in-house drivers and vehicles as well as the necessary experience of operating an on-demand service.

Microtransit vehicle, Wilson, NC

Finally, as the service progresses, the planning agency may come across situations whereby they need to switch the model of service delivery, e.g., from a turnkey model to a software acquisition model. Communicating such a transition with customers is important. Moreover, if an agency plans to terminate the turnkey contract with a private service provider and provide microtransit service through an in-house operation, it is important to ensure that the agency is well equipped with resources such as microtransit scheduling software and human resources skilled to operate the technology. In one of the microtransit pilot projects that we discuss in this study, the transit agency has been planning to replace the turnkey operation with an in-house operation after the pilot project concludes. However, terminating the contract with the current service provider would also mean that the transit agency either has to explore other software companies to purchase microtransit scheduling software or develop one in-house.

11.5. Selection of service provider

The experience of the transit agencies included in this study shows that the selection of the service provider is perhaps the most important determinant of microtransit success. The selection of a suitable service provider is even more important for microtransit projects implemented under a turnkey model of service delivery. Some transit agencies that we interviewed expressed concerns about the effectiveness of the service delivery model they had adopted during the pilot phase of microtransit. Other transit agencies that we interviewed were confident about the selection of service delivery model but regretted the selection of software provider in hindsight, expressing that their microtransit service would have been substantially more successful if they had selected a different service provider. While most agencies would be inclined towards selecting a service provider that would best address their financial constraints or selecting a service provider that has already established its brand in shared mobility, this might not always be the best choice. In fact, one agency that selected a service provider solely based on the bid price later experienced discontent with the operations of the service provider. More specifically, the service provider was entrusted to assist the transit agency in marketing the service, but realized that they had severely underbid after the contract was in place and did not make the necessary marketing efforts to reduce their costs. Insufficient marketing led to low ridership and higher operational costs per trip.

When selecting a service provider, the public agency should **carefully review the bids and be meticulous regarding the details in the contract**, particularly if there are significant differences in the total contract costs put forth by different technology providers. The public agencies should conduct detailed discussions with the technology providers to understand the details of the services offered. For instance, a technology provider may be well-known in the on-demand transportation service industry but may be unwilling to operate a call center. Similarly, many technology providers are new to the U.S market and hence may not understand the cost details of different requirements such as driver training, drug screening, and ADA compliance. Transit agencies should articulate their requirements in detail while issuing the request for proposal so the service providers that are unable to meet the requirements or whose operational policies would be in conflict with the requirements are filtered from the start. Further, it is important to investigate the background of the companies and their past experiences in other locations with regards to providing microtransit or on-demand transit services.

Moreover, the public agency should **clearly communicate their expectations from the microtransit service** and inquire if any of the policies from the service provider on daily operations of the service is at conflict with the expectations of the planning agency before starting the microtransit implementation. For instance, many disadvantaged residents in a city where microtransit is implemented may not have electronic payment options to use through the smartphone application. A service provider that operates with a policy of electronic payment verification in order to book a ride, despite the service being free of cost, may not be suitable for a public microtransit system. Hence, the transit agency should select a service provider that can address any required changes in technology and provide contextual flexibility in their policies to address the needs of the transit agency. Another important issue regarding microtransit that is distinct from fixed route is the use of virtual stops. Some technology providers do not visit the service areas in person to assess the safety and suitability of stop locations and the stops are selected solely based on algorithms tailored to achieve operational efficiency. If the microtransit is implemented under a turnkey contract, or under separate contracts, the transit agencies should require the technology providers to perform a safety assessment of the stops. If the technology acquisition model is adopted, transit agencies need to perform the safety audits themselves for microtransit stops.

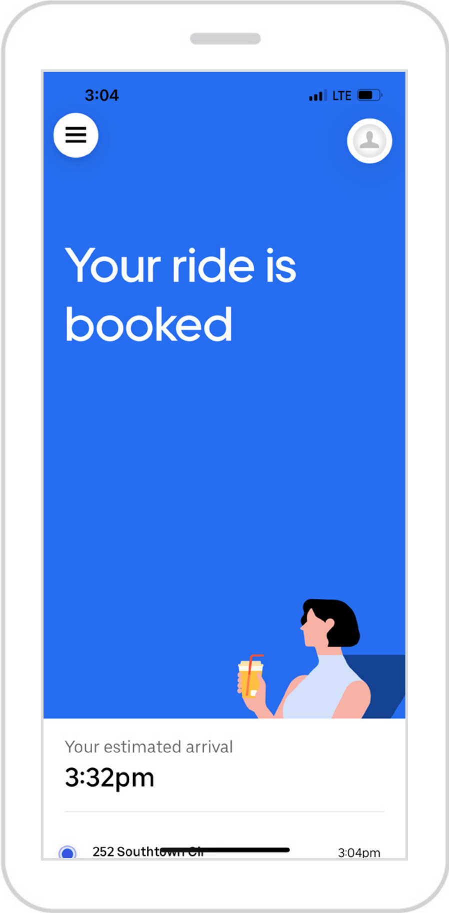
Public agencies should **require that contracts describe the services to be provided and other requirements in adequate detail**. Sections that are typically not well described or not discussed at all in the contracts we reviewed are related to alcohol and drug screenings, vehicle inspection, maintenance, and cleaning, accident management and insurance, reporting requirements, and facilities expected to be provided by the public agency.

Agencies should carefully and meticulously select the technology provider because **transitioning to a new provider comes with some challenges**. First, the agency will have to pay again the upfront cost (one-time fees or higher rates for the service) to initiate the service with the new provider. Second, changing technology providers could mean that the microtransit would operate under a **different mobile application** which could bring unexpected changes in trip booking and vehicle access. This could be particularly disruptive to some user groups, including elderly and people with disabilities.

Regardless of the decision on the service delivery model, an important lesson that the pilot projects provide is that the planning agencies should try to select service providers that are willing to adapt their algorithms to changing local conditions because the requirements of the service evolve over time. Further, it is in the interest of the transit agency to incentivize the service providers to explore innovative solutions to the challenges faced while operating the service. For example, the increase in the waiting time for service delivery with an increase in demand is a challenge that is common across multiple microtransit sites in our study. Solving this problem entails innovative solutions when the agencies are already operating under funding constraints. Moreover, regardless of the type of service delivery model, transit agencies should ensure that they procure microtransit scheduling software such that they understand how the algorithms can be altered to increase the priority for persons covered by ADA or any changes needed for microtransit operation.

11.6. Marketing

As suggested by previous studies (Brake et al., 2007), we also identified that marketing plays a vital role in the success of a microtransit system. Awareness among potential customers about the presence of a new microtransit service as well as the differences in the operational characteristics of the microtransit service and conventional fixed route transit is critical to its success. Though most pilot projects discussed in this study depend on external funding sources, efforts to increase the ridership for higher revenue in the operating stage may be necessary to ease the funding constraints of the project. The revenue associated with ridership will not increase unless a wide customer base is available to the project. The microtransit implementations presented in this study also corroborate that the transit agencies which emphasized marketing ended up earning remarkable increase in ridership. Furthermore, strategic marketing is crucial to encourage large employers in the service area to partner with the microtransit service so the service can be offered beyond normal operation hours for employees who need to travel during early morning or late evening hours.



App screenshot, Wake County, NC

Though marketing is an important component for ensuring the success of the microtransit projects, it has not received enough attention in pilot projects. Our examination of the pilot projects that operate in collaboration with the service providers shows that the success of marketing depends on joint efforts from both service provider and the planning body. Hence, if planning agencies adopt a turnkey model or separate contracts to implement the microtransit service, they should include marketing as an essential requirement before they approve the contract with the service providers. For instance, for one of the systems that we studied, the service provider was expected to market the microtransit service, but realized after the contract was put in place that they had significantly underbid so did not complete the marketing efforts as originally outlined in the contract. The service provider should be held to the marketing responsibilities in their contract to ensure that marketing is a continuous process that is completed throughout the project. This is important because the needs of the transit agency and the operational characteristics of the service may change over time, and to have the customers oblivious of the changes would pose a risk to the prospects of future growth. Both the users and all stakeholders should be continuously updated about the service. Transit agencies administering the microtransit system should oversee as well and collaborate in the marketing efforts as the planners in transit agency understand their clientele and their region better. For example, a transit agency could help the service provider establish relations with the stakeholders and the businesses in their service area and allow the service provider to tailor the marketing efforts so that a single and consistent point of communication between stakeholders and the service provider could be established. Further, some contracts we reviewed even required transit agencies to provide limited access to their social media handles to facilitate the service provider to quickly communicate any changes in the service to the public.

An important observation that we make across all microtransit sites is that they all use branded vehicles that either display the name of the service provider or the planning agency to market their service. This is a useful strategy as it attracts the larger population in the service area while adding legitimacy to the service.

11.7. Operational lessons

The ability to find a right balance in the trade off between convenience to each user and overall system efficiency is a critical component of microtransit operation. Each individual user desires convenient and accessible transit that provides on-demand, door-to-door service with minimal waiting time. User surveys have also demonstrated that users would prefer service beyond normal operation hours, on weekends, and with lower waiting time. However, aiming to provide a convenient door-to-door service with minimum waiting time to all users could require the agencies to compromise on other important service characteristics like low vehicle utilization (trips per vehicle per hour) under the financial and technological constraints within which the services are provided. Increasing the proportion of trips that are shared and distributing demand over time can lead to improvements in the system's performance without requiring additional vehicles and drivers. Innovative approaches for accomplishing these increases are necessary because the use of pricing is often not appropriate in the case of public transportation. To facilitate studies on these issues, the public agencies can collaborate with academic institutions which are continuously exploring novel methodologies to improve these emerging mobility technologies.

11.8. Transitioning beyond microtransit

As demand increases, microtransit will likely become too expensive to operate and it will need to be operated as a complement to other transit services. One of the microtransit systems we interviewed shared that they are currently able to serve roughly 4 trips per vehicle hour, which is considered by their technology provider as one of the highest vehicle utilization rates compared to other systems in operation. However, this is rather low when compared to a fixed route bus which can serve more than 40 trips per vehicle hour. Identifying actual rider origins/destinations, times, and price points has been a vexing issue for fixed route transit because it relies on stated preferences from potential riders. Successful microtransit programs uncover the true ridership base which can be leveraged to become the foundation of future public transit systems. Many of the trips currently served by microtransit are for daily commutes to work. Serving such trips by a shuttle service could be more reliable and convenient for users and relieve pressure from the on-demand system.

12. Conclusions

This study examines the operational characteristics of on-demand services in NC as well as the planning and implementation challenges and lessons learned. We premise our study on semi-structured interviews conducted with representatives of the transit agencies and other sources such as proposals, contracts with service providers, and operational statistics. From our interviews, operational data analyses, and literature review, several conclusions can be drawn.

The key finding is that there is no "one size fits all" method of microtransit to guarantee success. While microtransit works best as a complement to fixed route transit in areas where fixed route transit is less appropriate, such as low-density areas, there is still a variety of different residential patterns in these areas. Orange County, Wake County, and Wilmington seek to offer mobility solutions in zones near more urban areas, while Morrisville finds itself in between other cities. Meanwhile, YVEDDI and Wilson base their systems around smaller cities as an attempt to replace fixed route transit. The communities that are the early adopters of microtransit in NC vary greatly in their demographics, which some being significantly below the state averages for zero-vehicle households, poverty, and non-white population and some being much higher.

A community considering microtransit should determine what its goals are for the service and design a service that meets those goals. An agency planning a system should consider the efficiency and cost implications of its design, but keep in mind the customers that it is trying to serve. Saving money by reducing hours, relying on smartphones or credit cards, or utilizing drivers not trained in ADA requirements may shut out many populations that the program is meant to serve.

Microtransit vehicle, Wake County, NC

To aid communities in these discussions, this study determined the main purposes for instituting microtransit and questions to consider for each. Programs intended to help solve the first/last mile problem need to coordinate with local or regional transit systems, including making sure the system has access points to traditional transit and that it also operates during the times that people use transit. When replacing an inefficient fixed route system, it is important to understand what makes the system inefficient. A microtransit system may reveal the latent demand to design a better fixed route system down the line. When the purpose is to provide new transit in a low-density area, it is important to understand what the demand will be, both in terms of the overall amount and the geographic distribution.

Long-term success requires that any community considering microtransit take the time to adequately plan. All stakeholders should be part of the conversation, including transit agencies, cities, counties, as well as any large trip attractors, such as senior centers, business centers, large employers, and major supermarkets. Prospects for future funding should be identified, particularly if future expansion is a goal. A marketing plan should be developed that will reach the targeted populations. And potential problems, such as the ongoing driver shortage and ADA training, need to be recognized early. With these problems addressed and purposes identified, the type of program structure can be chosen: Turnkey, Technology Acquisition, or Separate Contracts. This will be largely dependent upon the resources of the agency, including staff size and skills, and how much day-to-day control the agency would like over the system. Finally, it is important to think both short-term and long-term. The decision to start with a turnkey system for convenience's sake may necessitate starting from scratch if the agency decides to switch its structure, change its scope, or find new vendors if the original proves inadequate.

Microtransit as an emerging mobility option has the potential to be highly effective in specific locations. So successful, in fact, that some relatively new microtransit systems are exploring how to meet the increasing demand. But, importantly, this success can be difficult to measure and address in cases where the technology provider owns the data, not the public agency.

The initial round of microtransit and on-demand pilots in NC are substantially different in key characteristics including the different purposes, operating areas, maturity of the service, operating policies, previous and existing transit services, and contract structures. Therefore, caution must be used when directly comparing costs or mobility outcomes between the study sites. As more pilots are planned and become implemented in NC, comparisons will become more meaningful, and it is important to continue assessing the costs, challenges, and lessons learned of this new transit mode. As with any emerging industry, there are some questions and concerns that need to be addressed. Primary concerns among the more established services are how to maintain effectiveness given the growth in demand and how to fund the program after pilot funding expires. Another concern is how to ensure ADA trips and other populations of special concern receive necessary services. Further research should focus on trip-level analysis to evaluate equity outcomes and how these systems are experienced by different geographies and users. User surveys will be necessary to better understand the rider experience. In addition, as more microtransit systems enter the market, the transit industry and research community should closely monitor key operating characteristics such as costs as well as mobility outcomes.

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