THREATS TO PUBLIC TRANSPORTATION PERFORMANCE MEASUREMENT: SPECIFIC EXAMPLES OF PERFORMANCE MEASUREMENT SHORTCOMINGS

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A dissertation submitted to the faculty at the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of City & Regional Planning in the College of Arts and Sciences.

Chapel Hill
2022

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ABSTRACT

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Threats to Public Transportation Performance Measurement:
Specific Examples of Performance Measurement Shortcomings
(Under the direction of Noreen C. McDonald)

The goal of this research is to explore threats to performance measurement in public transportation using a pragmatic approach that displays the author's broad set of research methods. The first paper addresses how rural public transportation systems measure success and whether this measurement is consistent with their stated goals. The research uses a qualitative analysis of success plans created by coordinated community transportation providers in North Carolina to understand the types of performance metrics they selected to measure themselves with and how well these metrics align with their stated mission, vision, and goals. In most plans, rural public transportation desires to be safe, reliable, and provide great customer service whereas their performance metrics are related to financial health and operational efficiency.

The second paper concerns the impacts of a significant state policy change related to Medicaid transportation. Using a case study methodology, this research analyzes the initial impacts of North Carolina's Medicaid Transformation on coordinated community public transportation. With such a substantial change in the Medicaid non-emergency medical transportation (NEMT), the public transportation industry in North Carolina was concerned the introduction of private for-profit transportation brokers would reduce NEMT trip volumes and revenues. This research documents the initial experiences of Medicaid Transformation in North Carolina from the public transportation perspective using a case study approach.

The final paper asks where and when buses experience recurring congestion and how impactful is this congestion. This research develops a methodology to locate where public bus routes experience recurring delay from roadway congestion and quantify the costs of the congestion by hour, mode, and roadway segment. Just as the roadway network performance degrades with predictable, recurring congestion, so does transit and school bus performance. The methodology created with this research will help public and school planners locate and quantify the service degradation, but also allow them to reroute or plan for technological or infrastructure enhancements to alleviate the delay.

For their patience, love, and support, I dedicate this dissertation to my supportive partner, Lauren, and our children, Luciana and Ruby. They encouraged, critiqued, distracted, and grounded me, which I desperately needed at many moments along this long journey. I know they sacrificed much over the years so we could achieve this goal.

ACKNOWLEDGEMENTS

In addition to the contributions of my immediate family declared in the Dedication, I would like to acknowledge my mother, Sarah MacManus, for her emotional and sometimes physical support during this journey and my father, Joseph Monast, for his encouragement, support, and academic insights.

Outside of the family, there are two key individuals that ensured this moment of success was achieved. Debra Collins actively encouraged and supported my pursuit of this degree as my supervisor and even after her retirement. My classmate, associate, and close friend, Mathew Palmer, has been my confidant and supporter throughout. I could not have approached completion of this degree without the professional, academic, and personal support and love of both of these individuals.

I would like to acknowledge and show appreciation for the co-authors who participated in the research contained within this dissertation: Jeremy Scott, Jonah Freedman, Narmina Murphy, Waugh Wright, Charlie Stanfield, Dr. Ruth Steiner, and Tim Brock.

Furthermore, I would like to recognize the contributions of members of the various committees who participated in my progress towards achieving the doctoral milestones: Drs. Noreen McDonald, Daniel Rodriguez, Daniel Findley, Eleni Bardaka, Bill Lester, Leta Huntsinger, Matthew Bhagat-Conway, Allie Thomas, Danielle Spurlock, and Meenu Tewari. Specific appreciation is warranted for three of these individuals. Dr. Daniel Rodriguez welcomed me into the doctoral program and served as my first advisor. Dr. Noreen McDonald accepted me

as her student and served as my advisor for years and through completion of the degree. And, Dr. Eleni Bardaka gave me perspective and encouragement as a colleague and committee member.

Also, I need to thank my coworkers for supporting me and sometimes having to cover for me due to academic commitments. This group of key supporters begins with Jeremy Scott and includes Jonah Freedman, Dr. Billy Williams, Dr. Ginny Blair, David Foote, Narmina Murphy, Rui Yang, Dr. Nagui Rouphail, and many, many others.

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LIST OF ABBREVIATIONS

ADA	Americans with Disabilities Act
CCATS	Carteret County Area Transportation System
COLTS	County of Lee Transit System
COVID	Coronavirus Disease
DHHS	Department of Health and Human Services
DPS	Durham Public Schools
DRT	Demand Response Transportation
DSS	Division of Social Services
FDOT	Florida Department of Transportation
FL	Florida
FTA	Federal Transit Administration
FY	Fiscal Year
GIS	Geographic Information System
GPS	Global Positioning System
GTFS	General Transit Feed Specification
HHs	Households
ITRE	Institute for Transportation Research and Education
ITS	Intelligent Transportation Systems
JCATS	Johnston County Area Transit System
MAP-21	Moving Ahead for Progress in the 21st Century Act
MS	Microsoft

NC	North Carolina
NCDOT	North Carolina Department of Transportation
NCHRP	National Cooperative Highway Research Program
NCSU	North Carolina State University
NEMT	Non-Emergency Medical Transportation
NTD	National Transit Database
OUTS	Onslow United Transit System
PHP	Prepaid Health Plan
PSTA	Pinellas Suncoast Transit Agency
RITIS	Regional Integrated Transportation Information System
TCRP	Transit Cooperative Research Program
TIMS	Transportation Information Management System
TOPS	Transit Organization Performance Scorecard
UF	University of Florida
USDOT	United States Department of Transportation
VTPI	Victorian Transport Policy Institute
VMT	Vehicle Miles Traveled
WAVE	Cape Fear Public Transportation Authority

CHAPTER 1: INTRODUCTION

Performance measurements in public transportation have been proposed for decades and volumes of data are available to create performance programs. This research explores three different applications of performance measurement in public transportation and reveals challenges facing the development and implementation of performance measurement programs. The overarching topic of performance measurement in public transportation is approached using three specific research questions:

1) How do rural public transportation systems measure success and is this consistent with their stated goals,

2) What are the impacts of a significant state policy change related to Medicaid transportation, and

3) Where and when do buses experience recurring congestion and how impactful is this congestion?

Paper 1 is a qualitative analysis of success plans generated by individual rural and community transportation providers in North Carolina. It aims to understand the types of performance metrics they selected to measure themselves with and how well these metrics align with their stated mission, vision, and goals in the same plans. Entitled "*An Analysis of Success Plans and Performance Measures for Rural Transit Systems in North Carolina"*, this paper was published in 2019 in the Transportation Research Record, Volume 2673 (Monast, 2019).

The conclusion that rural public transportation systems profess their desire to be safe, reliable, and provide great customer service is contradicted by their selection of performance metrics mostly consistent with traditional national metrics. These traditional metrics are easier to collect, but are not connected with their stated values of the transit systems. Professing an intent on accomplishing safety, reliability, and providing great customer service but measuring success with trips per hour and financial sustainability shows there is a disconnect between performance goals and performance measurement.

Paper 2 is a case study that documents the initial impacts of North Carolina's Medicaid Transformation on coordinated public transportation. This major legislation was primarily to control healthcare costs, but incidentally introduced private for-profit transportation brokers into the state for the first time. With such a substantial change in the NEMT service structure, the public transportation industry in North Carolina was concerned that the introduction of private for-profit transportation brokers would reduce NEMT trip volumes and associated revenues. These reductions would impact not only NEMT services, but also other community mobility programs. This research documents the initial experiences of Medicaid Transformation in North Carolina from the public transportation perspective using a case study approach that combines data from multiple sources and survey responses. The research findings have been shared widely among the public transportation community as a white paper.

This research is important because Medicaid transportation has historically formed the foundation of coordinated public transportation in North Carolina. Transit systems were concerned that the introduction of for-profit private transportation brokers would reduce program incomes and result in a contraction of service for customers not sponsored by Medicaid. Understanding the initial impacts of Medicaid Transformation on public transportation in North

Carolina will help inform policy changes for local transit systems as well as the North Carolina Departments of Transportation and Health and Human Services. In terms of performance measurement, this research shows that a large exogenous shock to the coordinated public transportation industry has had disparate impacts on local transit systems.

Paper 3 develops an analytical methodology to locate and quantify where public bus routes experience recurring delay from roadway congestion. The association with performance measurement is that public bus performance, reliability, and desirability are degraded when buses are slowed by predictable congestion. This research employs advanced Geographic Information Systems analytical techniques to combine roadway congestion data, fixed route data, and school bus route data. This research was funded by the Southeastern Transportation Research, Innovation, Development and Education Center (STRIDE), the United States Department of Transportation (USDOT) Region 4 University Transportation Center. Staff and students with the University of Florida (UF) and North Carolina State University (NCSU), where the author is employed, collaborated on the research with the author as Principle Investigator and primary research designer. The final report is entitled "*Locating and Costing Congestion for School Buses and Public Transportation*" (Monast et al, 2022).

Just as the roadway network performance degrades with predictable, recurring congestion, so does transit and school bus performance. Transit and school bus planners are often aware that the system has degraded over time, but may not be attuned to precisely where and by how much. As such, they find themselves asking for increased operational funds to maintain their existing levels of service in terms of bus frequency and customer convenience. Meanwhile, their ridership is likely falling because ride times are increasing. The methodology that this research has created will help public and school planners explain why (and where) the service

degradation is occurring but also allow them to reroute or plan for technological or infrastructure enhancements to alleviate the delay. As for this research's relationship to performance measurement, recurring congestion is an exogenous factor that slowly degrades the performance of public transportation.

Performance Metrics in Public Transportation

Performance measurement in the public sector, including transportation, is becoming more prevalent (National Cooperative Highway Research Program, 2011). As the public transportation industry experienced ridership loss, bankruptcy, and federal bailouts, researchers and public officials became very interested in how these subsidies impacted transit systems. Since at least as far back as 1975 (Gilbert, 1975) and likely much earlier, attempts have been made to classify and assess transit system performance. The initial focus of these attempts was to address the "alarming cost escalation of the previous decade" (Puchers, 1983).

Many of the first performance measurement attempts identified the difficulty of performance measurement programs due to the lack of standardized reporting at the national level (see for example Vaziri 1984). The National Transit Database was established partially in response to the need for data, but also related to the public sector performance measurement trends in general.

The National Transit Database (NTD) collects monthly and annual service, financial, and safety data from federally funded urban and rural public transportation providers in the United States (Federal Transit Administration, 2022). The primary purpose of the NTD declared in the legislative requirement is that the reporting system *"shall contain appropriate information to help any level of government make a public sector investment decision"* (Federal Transit Administration, 2014).

Performance measurement programs can be designed to assess the performance of a single agency against itself, a process explained thoroughly in A Guidebook for Developing a Transit Performance-Measurement (Kittelson, 2003). One example of a long-standing intra-agency performance measurement program is the Transit Organization Performance Scorecard developed for the regional transit system in and around Rochester, New York, which stands out because of its longevity (Regional Transit Service, 2015).

Intra-agency performance measures control for differences in service areas, financial capacities, and data collection processes that may occur between transit agencies, but fail to provide any comparison to how the agency is doing in relation to others. To provide the perspective of how a transit system compares to others, peer comparisons are often employed. Peer comparisons require the selection of appropriate measures in addition to appropriate peers.

There are two primary techniques for peer selection- service characteristics or service area characteristics. Service characteristics can be roughly defined as data available in the National Transit Database or other transit industry datasets and include trips, miles, hours, and finances (KFH Group, 2008 and 2009; Ripplinger, 2010). In contrast, service area characteristic methods are more likely to be derived from the US Census or other sources outside of the transit industry and include geographic and demographic descriptors of the service area (Brons, 2005; Arndt, 2011; Radow, 2011).

The performance of public sector industries is often measured in terms of the three E's, equity, efficiency, and effectiveness. The large number of stakeholders and complexity of public sector industries coupled with the fact that they historically have sought to balance measures instead of maximize them makes it challenging to successfully implement performance measurement programs in these industries (Brignall, 2000). It is impossible to measure

everything, so successful performance measurement programs implement the idea of concept reduction where complexity is reduced into individual, measurable components (Doreen, 2010). These programs often suffer from inexact measurement, measure fixation, and a myriad of other weaknesses.

The presence of a consolidated national dataset (NTD) should theoretically make performance measurement and comparison between transit systems easy. The NTD has been in existence for 2 decades, the standard reports available on the website are primarily snapshots and trends, not comparisons. Although much research has been conducted, volumes of data are available, and many proposals have been put forth, the industry has yet to widely adopt a performance measurement methodology that can be used to compare performance between transit systems. Even with the uniformity of NTD data, attempts at establishing peer groups and performance measurement systems have been consistently rejected because the methods fail to account for unique local circumstances and direct comparisons are not "apples to apples" (KFH Group, 2009).

However, widely available, standardized data must still be analyzed in a meaningful way. When the breadth of data elements in the NTD are combined with Census and other sources, the resulting dataset contains hundreds of data elements that can be combined into many hundreds of performance metrics. In A Guidebook for Developing a Transit Performance-Measurement, for instance, the report identifies over 130 metric families and 400 individual metrics available for use (Kittelson, 2003).

Because of these and other complexities, the industry has yet to coalesce around a set of widely accepted performance measures. The conversation continues and new performance measures are proposed on a regular basis. Although none have so far gained widespread

acceptance, performance measures are found in funding formulas. As an example, the formula for Section 5307, the primary source of federal urban fixed route subsidies, allocates 9.2% of the funds are allocated using on an “Incentive” portion associated with performance based on passenger miles and operating cost (Federal Transit Administration (1), 2015).

CHAPTER 2: AN ANALYSIS OF SUCCESS PLANS AND PERFORMANCE MEASURES FOR RURAL TRANSIT SYSTEMS IN NORTH CAROLINA

Abstract

Performance measurement and funding allocation based on these measurements are becoming increasingly popular in public transportation. Understanding what is important to transit systems is critical to properly assess them on their operational and administrative performance. Our research goals were to determine how rural transit systems in North Carolina define success, what performance metrics the systems select for themselves, and why they selected those metrics. Each transit system was required by the North Carolina Department of Transportation to create a Success Plan for themselves that consisted of a mission statement, vision statement, values and a scorecard that contained performance metrics. Our analysis of these Success Plans shows that rural transit systems broadly define their values based on customer service, safety, and reliability. However, aside from safety, the specific metrics that the systems use for evaluating their performance are not well-connected to these values. This lack of consistency within the Success Plans means that rural transit systems are not selecting performance metrics that complement their stated goals. This lack of internal consistency could have many causes and we conducted interviews with public transit administrators in North Carolina to try and understand the causes. From these interviews, we were able to determine that the lack of internal consistency in the plans could be partially attributed to the following: (1) system administrators were not aware of the importance of internally consistent plans; (2) system

administrators had difficulty creating metrics; and (3) system administrators included metrics that they felt the state wanted to see.

Introduction

There is no "best" way for public transit agencies to measure their performance. Every performance metric used in the industry has its own advantages and drawbacks. Overall, research is generally conflicting on the idea of performance metrics, with some literature pointing to the benefits of using such tools, while other literature cautions their use due to underlying biases. There is also a significant gap in published research dealing with performance metrics for rural transit systems.

Literature Review

Research on performance measurement in the public sector has been surprisingly sparse (Poister, 2013). With that being said, there have been a handful of studies that have looked at performance measures for urban public transit systems, however, very little research has been done on performance metrics and rural systems. This distinction between system types is important because rural systems operate with service designs (low, dispersed demand) that are completely different than their urban counterparts (high, concentrated demand). In a literature review of over 40 articles dealing with performance metrics and public transit systems, (De Borger, 2002) included only one study that looked at performance metrics for rural transit systems.

Dooren (2010) describes the role of performance metrics in public policy: evaluators use information gained from them to assess performance and base future decisions on these

evaluations. We see that the inverse of this is common as well, where policy decisions are made in order to improve performance based on established metrics. For example, with the adoption of MAP-21 in 2012, states were required to implement performance measurements to help improve the decision-making process (Federal Transit Administration, 2014). The overarching policy goal of implementing these performance measures was to incentivize more efficient use of resources and to help in tracking performance longitudinally. A National Cooperative Highway Research Program (NCHRP) report found that most state departments of transportation (30 out of 43 respondents) have some performance metrics in place for their public transportation systems (National Cooperative Highway Research Program, 2011). A major motivator of these performance metrics was to provide accountability to stakeholders, such as state legislators.

Though performance metrics have become more popular, they still have limitations. Researchers caution oversight organizations from implementing performance metrics without first understanding the ramifications of their implementation. Firstly, public sector organizations often have varying needs and use performance metric programs that are too narrow in scope, making it difficult to account for these varying needs (Speklé, 2014 and Smith, 1987). Furthermore, the implementation of performance metrics does not necessarily lead to improved outcomes (Jacobsen, 2014). Gleason and Barnum note that transit systems will likely "game" performance metrics in order to maximize how their performance is perceived (1982). For example, if a state department of transportation implements a ridership metric for the transit systems in its state, these systems would be incentivized to carry as many riders as possible. This would likely lead to a service design which favors short trips in the densest areas of that system's jurisdiction, leaving individuals who require longer trips located in less dense areas with no transit options. A NCHRP report shows that many states emphasize the importance of selecting

measures that are meaningful to the type of service that is being provided; rural transit systems often need to look past cost-efficiency measures, as those are not their service goals, and implement social value and quality of life performance measures (National Cooperative Highway Research Program, 2011). The states that do not emphasize the importance of meaningful metrics should be wary of the implications that such policy decisions may have because transit systems could select performance measures that do not align with their goals and objectives.

The importance of having a plan with performance measures that correspond with goals and objectives cannot be overstated. Consistency ensures that the plan is a useful tool in the decision-making process (Pickrell, 2001). A plan that has performance measures that do not align with the system's goals and objectives are problematic because they are not accurately assessing the system on its performance. Spekle conducted an empirical analysis on public organizations with performance programs and found that those who have performance measures aligning with their goals and objectives outperform organizations that do not (2014). Similar issues are prevalent in the NCDOT Success Plans. The Success Plans that lacked internal consistency are problematic, as the transit administrators cannot adequately measure their system's success, thus hindering their decision making and overall performance.

Background

In 2016, the Public Transportation Division of the North Carolina Department of Transportation required each of the 81 rural transit systems in North Carolina to develop a Success Plan which contained their respective mission, vision, and values as well as performance metrics with measurements that defined success for the upcoming fiscal year (North Carolina

Department of Transportation, 2018). A consultant was contracted by the NCDOT to help the rural transit systems develop success plans. Representatives from each transit system attended one of four sessions led by the consultant that taught them how to make a Success Plan. The training session was only meant as a guide and the consultant did not advise the systems on what content to include in their plans. It was emphasized in the sessions that all the decision makers in the transit system's organization should participate in the plan-making process to help determine comprehensive goals.

Each system was directed to create a Success Plan containing a mission statement, a vision statement, values, and a scorecard. The mission statement and values were to describe the goals of the agency and establish what service characteristics were important to them. The vision statement was intended to set broad future goals for the agency. The scorecard was intended to be a detailed set of weighted metrics for the agency to rate themselves on a quarterly basis, with the metrics adding up to a total of 100 points.

Attendees returned back to their respective systems and created a plan without further consultation from the NCDOT. After allowing a few months for the systems to complete their Success Plans, the NCDOT collected the plans from the transit systems and we compiled the information for research and analysis. Figure 1 displays an example of a mission statement, vision statement, and values, and Figure 2 displays an example of a scorecard.

Our sample consisted of Success Plans from 76 of the 81 rural transportation systems in North Carolina; five (5) systems did not submit plans. Of the systems that submitted plans, 54 submitted fully complete plans and 22 submitted incomplete plans.

Mission Statement

To provide Transportation that enhances quality of life

Vision Statement

To provide Transportation that is safe, efficient, affordable and respectful

Values

1. Anticipate customer needs
2. Be respectful, empathetic and courteous
3. Be a team player
4. Strive for continuous improvement
5. Show up positive and prepared to share ideas
6. Be productive daily
7. Show pride in all we do / what we do is important

Figure 1. Example Success Plan

Agency Scorecard					
Guiding Management Principal	**Metric Name**	**Performance Goal**	**Goal Points**	**Owner**	**Definition**
Financial Sustainability	Apply for Alternative Funding	100%	10	Administrative Assistant-	Meet with Department grant specialist to explore additional Grant applications for submission
	FY 2017 Additional Funding approved	100%	10	Director-	Approval to enter agreement for any new grant funding
	Increased Customer Trips	2.0 trips per hour	5	Asst. Director -	Increase trips per hour to 2.0 in the first year with possible increases in following years.
	Decreased Wait List	5%	5	Office Support III	Reduction of waiting list by 5%
		Total	30		
Employee Success	New Hire Process	30%	5	Administrative Asst.	Review/update new Employee Onboarding Procedures & Create Annual Satisfaction survey
	Training	100%	5	Transp. Asst. -	Training hours per employee = no less than 10 per fiscal year
	Employee Engagement	100%	3	Transp. Asst. -	Number of employees attending training or make up training = 100%
	Satisfaction Rating	90%	5	Administrative Asst.	Positive Satisfaction rate from staff is no less than 90%
		Total	18		
Excellence in Customer Satisfaction	Customer Satisfaction	Every 90 Days	2	Transp. Asst. -	Distribution of 25 random surveys per quarter
	Concern Resolution	10 days	15	Asst. Director-	Concerns investigated and resolved
	Customer Focus	95%	15	Transp. Asst. -	Surveys returned have a positive result equating no less than 95%
		Total	32		
Commitment to Safety and Security	Passenger Safety	100 %	5	Director-	Create a policy for emergency exit evaluation
	Scheduled Emergency Exits Assessment	Every 90 days	5	Transportation Director & County Fleet Manager	Creation of schedule for "clinic" to assess condition of exits every 90 days
	Repair Resolution	5 days	10	County Fleet Manager and County Garage Staff	Perform the needed repairs resulting from the evaluation within 5 days of discovery
		Total	20		
		TOTAL	**100**		

Figure 2. Example Scorecard

Plan Methodology and Analysis

We compiled the 76 Success Plans into a single file and split the analysis of the plans into four parts based on the four sections of the plans: mission statements, vision statements, values, and metrics. Each section was qualitatively coded to allow consistent analysis of the contents of the Success Plans. Codes were also assigned a "family" based on the type of code it represented, with codes assigned to the same type of text grouped in the same family. For example, honesty and friendly were both assigned to the customer focus family. For clarity, details on coding methodology specific to particular sections of the Success Plans (mission statement, vision statement, values, or scorecard with metrics) can be found in each part's respective section below.

We used Atlas.ti software to code the plans. Atlas.ti is a qualitative coding software that allows users to assign, combine, and edit codes that were assigned to the plans. All plans were broken up by section, imported into Atlas.ti as a text file, and then assigned codes using an emergent coding process. Emergent coding is a qualitative technique by which text is read multiple times and coded in order to accurately extract all themes from the text. In this research, the text was read through three times. The first reading was done to become familiar with the plans and to pick out overall themes. In the first reading, no codes were assigned, however, general families were identified and recorded. In the second reading, the majority of the coding was performed. Using the previously identified families as a guide, codes were generated and assigned based on the content of the plan. After the second reading, all codes were assessed and consolidated where possible. For example, dependable and reliable were combined into one code. Finally, a third reading was carried out to ensure all consolidated codes were still assigned appropriately, and that no codes were assigned incorrectly or skipped altogether.

Mission Statements

Seventy (70) of the 76 plans submitted by the rural transit systems include a mission statement. We identified four (4) code families based on these mission statements. These code families were service area, service design, target population, and service characteristic. The identified families are mentioned in most of the plans and are useful for determining common elements between and within the plans.

After analyzing the codes, we determined from the mission statements, the service characteristic family contains the richest data for understanding a systems' priorities, as it describes how the system operates its service. The service area, service design, and target population families lack real specificity and variability. We therefore did not analyze them in-depth.

A summary of the most common mission statement codes from the service characteristic family can be seen in Table 1. Only safety (76%) and reliability (51%) were identified as key components because they were included in more than half of systems' mission statements. Efficient (31%), Affordable (29%), and Purpose (20%) were the next most frequent codes. This analysis demonstrates that the defined missions of rural transit systems in North Carolina vary widely.

Table 1. Summary of Mission Statement Service Characteristic Codes

Mission Statements	
Service Characteristic	**Frequency**
Safety	76%
Reliable	51%
Efficient	31%
Affordable	29%
Purpose	20%
High Quality	17%
Customer Service	13%
Accessibility	11%

Vision Statements

Sixty-eight (68) of the 76 plans included a vision statement. The vision statements reveal the long-term ambitions of the systems. The vision statements are broader and more abstract than the mission statements, values, and metrics, making it more difficult to analyze the similarities and differences of the vision statements between plans. For example, one system's vision statement was "Transit without borders!!!". Because of the broad nature of these vision statements, we did not carry out an in-depth analysis of this section of the Success Plans.

Values

Seventy (70) of the 76 plans submitted by the rural transit systems to the NCDOT include values. In general, there are seven (7) value codes per plan (with a minimum of one (1) code and a maximum of 17 codes). These values are typically formatted one of two ways: (A) Systems created a list of values. For example, one system said its values were "Service, safety, environmental responsibility, innovation, teamwork, community orientation, and fiscal responsibility." An example of how these values were coded can be seen in Figure 3, with the families listed first and the codes listed after the dash. Or, (B) Systems added more detail,

writing a sentence about each value to explain the value in more depth. For example, one system stated its values as "Maintain an ethical environment when delivering transportation services; maintain respect throughout the organization with staff, contractors, and citizens; maintain good communications with community for collaboration; maintain a high level of professionalism when conducting all business."

We identified nine (9) families and 44 codes based on the contents of the values. The families chosen are mentioned frequently in the plans and were selected to help determine common elements between and within the plans.

Value Families:

- Customer focus- describes the user experience
- Community focus- emphasis on the community
- Compliance- meets state and federal regulations
- Delivery of service- focus on operations
- Employee- describes employee expectations
- Environment- reduces environmental impacts
- Financial- focus on budget
- Safety- limits the number of accidents/incidents
- Service design- describes how service functions

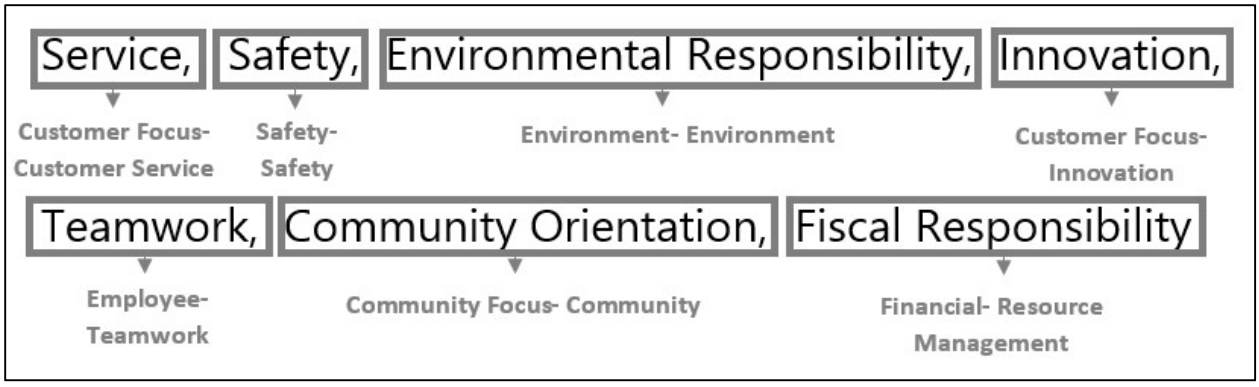


Figure 3. Example of Value Coding (Family- Code)

First, we looked at how frequently each family was mentioned in the systems' values. Breaking out the codes this way shows a better picture of the content of the transit systems' values, as the customer focus family is aggregated here and not spread out into many different codes. Nearly every plan contained at least one code from the customer focus family (96%) and a majority of plans also contained codes from the safety family (73%) and employee family (70%). A summary of this can be seen in Table 2. Note that in this table, "Total Occurrences" is the total number of times a family was mentioned in the values (many plans had the same family more than once in their values) and "Plan Frequency" represents the percentage of the plans that contained at least one instance of the family.

Table 2. Summary of Value Coding by Family

Family Name	Total Occurrences	Plan Frequency
Customer Focus	258	96%
Safety	52	73%
Employee	64	70%
Delivery of Service	23	33%
Financial	20	21%
Community Focus	8	10%
Service Design	5	7%
Environment	2	3%
Compliance	1	1%

We also analyzed the values by looking at the frequency of each code. Similar to the mission statements, safety (71%) is the most common value and is the only value mentioned by at least half the systems. Customer focused codes such as customer service (49%), respectful (36%), reliable (34%), and improvement (33%) were commonly used. Efficient (34%) and teamwork (34%) were also used relatively frequently. A summary of the twenty most common value codes can be seen in Table 3. Note that in this table, "Total Occurrences" is the total number of times a code was mentioned in the values, including codes that occurred more than once in the same plan. "Code Frequency" represents the percentage of the plans that contained that code at least once.

Table 3. Summary of Value Coding by Most Common Codes

Values			
Family Name	**Code Name**	**Total Occurrences**	**Code Frequency**
Safety	Safety	54	71%
Customer Focus	Customer Service	34	49%
Customer Focus	Respectful	27	36%
Delivery of Service	Efficient	25	34%
Customer Focus	Reliable	24	34%
Employee	Teamwork	24	34%
Customer Focus	Improvement	23	33%
Customer Focus	Friendly	19	27%
Customer Focus	Professional	17	24%
Employee	Positive Attitude	16	19%
Customer Focus	Honesty	15	21%
Financial	Resource Management	15	19%
Customer Focus	Adaptive	14	17%
Employee	Value Employees	13	16%
Customer Focus	Communication	11	16%
Customer Focus	Innovation	10	14%
Employee	Training	10	14%
Community Focus	Community	9	13%
Customer Focus	Accountability	8	11%
Customer Focus	Excellence	7	10%

Scorecard and Metrics

Sixty-five (65) of the 76 plans include a scorecard with metrics. The scorecard is how the transit system says it will measure its performance. Reviewing these metrics is another way to determine where the transit systems place importance.

When creating their plans, the systems identified guiding management principles and then created performance metrics that fell within those principles. They also assigned a weight to that metric, with the total weight adding up to 100. Within the scorecards, there are a total of 854 metrics, with each plan having about 11 metrics. Figure 2 displays an example of a submitted scorecard where the financial stability metric scores add up to 30 points, the employee success

metrics add up to 18 points, the excellence in customer satisfaction add up to 32 points, and the commitment to safety and security add up to 20 points.

After reviewing every scorecard, ten (10) metric families were identified, and each metric was coded with one of these families. This allowed us to identify general themes in the metrics, the types of metrics commonly used, and the metrics not being addressed. Table 4 provides a list of the metric families and summarizes the counts, average, minimum, and maximum frequencies by family.

Metric Families:

- Compliance- meet state and federal regulations
- Delivery of service- focus on operations
- Employee- describes employee expectations
- Environment- reduce environmental impacts
- Financial- focus on budget
- Planning- creates a framework to complete a task
- Procurement- acquire new vehicles
- Quality of Service- measure of how good service is
- Safety- limit the number of accidents/incidents
- Service design- describes how service functions
- Technology- improve equipment

Table 4. Summary of Metric Coding by Family

Metrics					
Family	**Count**	**Percentage of Total**	**Average Metrics per Plan**	**Minimum Metrics per Plan**	**Maximum Metrics per Plan**
Quality of Service	217	25%	3.3	0	10
Safety	180	21%	2.8	0	9
Financial	159	19%	2.4	0	6
Employees	120	14%	1.8	0	6
Delivery of Service	108	13%	1.7	0	6
Marketing	26	3%	0.4	0	3
Compliance	18	2%	0.3	0	3
Technology	16	2%	0.2	0	4
Procurement	5	1%	0.1	0	3
Planning	3	0%	0	0	1
Total	**854**	**100%**	**13.1**	**5**	**25**

From Table 4, we can see that systems most frequently measure themselves on quality of service (25% of all metrics), safety (21%), and financial (19%) metrics. This table displays the most important metric families to the systems, as this is how they grade their performance each quarter. We also examined the scorecards to determine if the weight placed on the metric was significant. However, this analysis produced near-identical results to the table above, suggesting that the systems were weighting some metric families proportionate to their frequency.

Internal Consistency

After completing the emergent coding process and making initial observations about the dataset, we synthesized themes across Success Plan sections and analyzed how each section related to the others. We identified shared elements between the mission statements and values - safety, reliability, and customer service seem to be most important, as these codes appeared frequently. We also found that themes in the values were not adequately specified or measured within the scorecards, pointing to a lack of internal consistency within the Success Plans. Internal

consistency is the idea that each individual section of a system's Success Plan reflects the same goals and priorities.

To determine the internal consistency of each plan, we matched the systems' self-stated values (what they deem important) with their scorecard metrics (how they will be measuring their performance). We selected values because it is the most specific and detailed section that explains the goals of the Success Plans. Vision statements are too broad and mission statements do not provide specific enough details to analyze. Any system that submitted an incomplete plan without values or a scorecard was excluded from this analysis. Table 5 displays an example scorecard with low internal consistency. Note that in Table 5, the only value that has a corresponding metric is safety.

Table 5. Example Scorecard with Low Internal Consistency

System Scorecard				Assigned Codes and Corresponding Value	
Principle	**Metric**	**Goal**	**Points**	**Metric Family**	**Value Code Corresponding to the Metric**
Commitment to Quality	Program Manager Keep Everyone Informed	100%	6	Delivery of Service	none
Commitment to Quality	Internal Team Communications	100%	5	Quality of Service	none
Compliance with NCDOT	AssetWorks Maintenance Reports	100%	5	Compliance	none
Compliance with NCDOT	On-Time OpStats Reports	100%	5	Compliance	none
Compliance with NCDOT	On-Time Draws in Partner Connect	100%	5	Financial	none
Customer Service	Safety Aboard Vehicles	5%	7	Safety	Safety
Customer Service	On-Time Performance	10%	7	Quality of Service	none
Customer Service	Vehicle Cleanliness	5%	4	Quality of Service	none
Financial Stability	Billable Rate	100%	7	Financial	none
Financial Stability	New Funding Sources	50%	4	Financial	none

After matching values with corresponding metrics, we broke the metrics out to determine internal consistency by family. Our analysis yielded mixed results, showing us that many metric families have moderately high internal consistency, while others have much lower internal consistency. Overall, the Success Plans are 44% internally consistent when matching values to their corresponding metrics. Safety (75%) and quality of service (59%) are the most internally consistent metric families while families with low internal consistency include delivery of service (36%), employees (26%) and financial (22%). Table 6 summarizes this information.

Table 6. Internal Consistency of Metric Families without Values Codes

Metric Family	No Matching Value	With Matching Value	Total	Internally Consistent
Safety	45	135	180	75%
Quality of Service	89	128	217	59%
Delivery of Service	69	39	108	36%
Employees	89	31	120	26%
Financial	124	35	159	22%
Procurement	4	1	5	20%
Technology	13	3	16	19%
Compliance	16	2	18	11%
Marketing	25	1	26	4%
Planning	3	0	3	0%
Total	**477**	**375**	**854**	**44%**

We also analyzed the inverse of this – how many of the systems' value codes had corresponding metrics. To determine the internal consistency of the plans this way, we utilized the same method as above, except we matched metric families to the systems' values. Overall, the Success Plans are 33% internally consistent when matching metrics to their corresponding values. The analysis once again yielded mixed results. Safety (75%) and delivery of service (52%) families have high internal consistency while employee (28%) and customer focus (26%) families have low internal consistency. For instance, the customer focus family comprises 60% of all values and is included in 96% of systems' plans (see Table 3). However, only 26% of the plans include metrics related to customer focus. Safety, on the other hand, shows up consistently across the plans, with 71% including safety as a value and 75% of these plans have safety-related metrics. Table 7 summarizes this information.

Table 7. Internal Consistency of Value Families without Metrics

Value Family	No Matching Metric	With Matching Metric	Total Values	Internal Consistency
Compliance	0	1	1	100%
Safety	13	39	52	75%
Delivery of Service	11	12	23	52%
Financial	13	7	20	35%
Employee	46	18	64	28%
Customer Focus	190	68	258	26%
Community Focus	8	0	8	0%
Service Design	5	0	5	0%
Environment	2	0	2	0%
Total	**288**	**145**	**433**	**33%**

Using these two methods, we were able to ascertain how internally consistent the Success Plans are based on the plans' elements. Some elements, such as safety, are captured well throughout the systems' plans. However, others, such as customer focus and employee families, are not captured as well. This shows that there is a gap in what systems identify as their values and how they are evaluating themselves on their scorecard.

Interview Methodology and Analysis

After establishing that many of the systems' Success Plans lacked internal consistency, we conducted interviews with transit administrators to understand why the plans were not internally consistent. These administrators led the plan creation process for their respective systems. In total, we interviewed eight people from eight different rural transportation systems. Our sample selection of interview subjects was purposeful. Four of the systems we chose had plans that had high internal consistency and four of the systems we chose had plans with low internal consistency. These systems were hand selected in an attempt to get feedback from a wide variety of perspectives; the systems chosen were geographically dispersed across the state

and ranged widely in size (from 20,000 annual passenger trips to 2 million annual passenger trips). These eight transit system administrators represent the views of their agency only, but the insights they offer are help to begin understanding the role of internal consistency.

The person in charge of the Success Plan at each agency was most commonly the director of the agency (6). However, an administrative assistant (1) and transportation coordinator (1) were also interviewed. When arranging the interviews, we requested to speak with the representative who led the plan-making process for the agency. The purpose of these interviews was to determine the process each system followed to create their plan, which staff members were involved in the plan creation process, how they selected their mission statement and values, how they came up with their performance metrics, and to solicit feedback regarding the process.

From the interviews, we learned that seven (7) out of eight (8) transit administrators attended one of the training sessions put on by the NCDOT prior to creating their system's Success Plan. The lone outlier was on medical leave during the period. Seven (7) out of eight (8) transit administrators created their Success Plan with consultation from other staff members in their agency and/or their advisory board, as requested by the NCDOT. Only one interviewee stated that the plan was made with no help. When creating their mission statements, half of the interviewees stated that they already had a mission statement, and therefore used their existing mission statement for their Success Plan.

An overwhelming consensus among the interviewees was that creating the Success Plan was an arduous task. Multiple system administrators noted they had difficulty coming up with metrics and were not sure what metrics to include in their scorecard. Many also felt that the plans were simply another piece of paperwork the NCDOT was requiring of them. Others noted they were already doing the things the Success Plan required, just not in the same format. The initial

lack of communication between the NCDOT and the systems on Success Plans deadlines seemed to be the biggest frustration. These frustrations have now subsided, as the systems are now aware of expectations and are familiar with the process.

Multiple systems stated that the Success Plans have helped the system with planning, which was one of the NCDOT's goals. Yvonne Hatcher of Brunswick County Transit stated "I think having the plan is a good thing…so that you have something to share with the people." In her case, she uses the plan as a community outreach tool so the public can see how the agency is performing. Marie Gunther of Clay County also noted that "the Success Plans were a good planning tool, especially because it was my first year being Director." No interviewees felt that the Success Plans had hurt their system.

There are two important findings from these interviews. The first is that half (four out of eight) of the administrators felt that some of the metrics in their Success Plan conflicted with local goals and objectives, though many could not cite specific metrics. One administrator cited "subsidy per customer trip" as a metric his system did not care about, but they included anyway. Another administrator stated that "At one time, our advisory board wanted to measure expenses differently, [but we couldn't]… we have to do what the NCDOT wants us to do because they are the one providing the funding." A third administrator said "what needs to happen is [NCDOT] needs to sit down with us and find out what the [transit system] sees as being successful." The biggest takeaway from this research is that systems are including certain metrics because they believe the NCDOT wants to see them. These metrics are contrary to local goals and therefore are improperly assessing performance. There is a clear gap between what the state wants to see and what many local transit systems think is important.

The second important finding from these interviews is that the systems were not aware of the idea of internal consistency when creating the plans. Only one administrator who was interviewed stated that she was aware of the concept. Because the systems were not aware of the concept of internal consistency, we can assume that many of the internally consistent Success Plans were not created that way on purpose. We can also partially attribute the lack of internal consistency within the plans to the lack of understanding and awareness of the importance of the concept.

Conclusions

The growing popularity of performance measures and the increasingly common practice of incorporating performance measures into funding allocation formulas makes understanding the self-selected performance metrics in the Success Plans increasingly important. Based on our analysis, we were able to establish how rural transit systems in North Carolina define success and determine what performance metrics the systems are choosing for themselves to measure this success. According to their mission statements and values, these rural transit systems are most focused on safety, reliability, and customer service.

By comparing a system's stated values with the performance metrics they assigned for themselves, we were able to show that rural transit systems in North Carolina have not been able to develop metrics that adequately measure their own values. Overall, low internal consistency exists within the Success Plans, with less than half of system's stated values having a corresponding metric and vice-versa. Understanding this gap between what systems view as important and how they are measuring their success is key to improving performance measures in the future. By conducting interviews with transit administrators in the state, we were able to

explore why some of the Success Plans lacked internal consistency. This gap can be partially attributed to following reasons: (1) system administrators were not aware of the importance of internally consistent plans; (2) system administrators had difficulty creating metrics; and (3) system administrators included metrics that they felt the state would want to see.

If local transit systems are unable to adequately measure their goals with available data, this should give pause to state departments of transportation, the Federal Transit Administration, or other authorities because they should be cautious in establishing goals that are severely out of alignment with local interests. Tying these incongruous goals to funding would be a particularly troubling practice. Developing performance measures that take systems' values into account and supplying the transit systems with these metrics could help the systems improve their scorecards and provide them with the ability to measure themselves based on what they deem are their goals. Communication between state departments of transportation or the Federal Transit Administration and local transit systems is critical so that expectations are clearly delineated and each agency's goals and objectives are known. Contrary to top-down approaches, which are commonly used today, taking a more collaborative approach to performance metric development and implementation would have a significant positive effect on rural transit systems' performance.

CHAPTER 3: MEDICAID TRANSFORMATION AND NON-EMERGENCY MEDICAL TRANSPORTATION IN NORTH CAROLINA: *INITIAL EXPERIENCES FOR COORDINATED PUBLIC TRANSPORTATION*

The purpose of this research is to document the initial experiences of coordinated public transportation providers in North Carolina during the first phase of Medicaid Transformation where the NC Department of Health and Human Services (DHHS) introduced Prepaid Health Plans (PHPs) and private, for-profit Medicaid transportation brokers. Prior to Medicaid Transformation, coordinated public transportation was often the provider of choice for Medicaid non-emergency medical transportation (NEMT) that originated from the county-based Division of Social Services (DSS). The volume of NEMT trips and revenues formed the financial and service foundation of many of the other community-based mobility programs supported by the transit systems.

With such a substantial change in the NEMT service structure, the public transportation industry in North Carolina was concerned that the introduction of private for-profit transportation brokers would reduce NEMT trip volumes and associated revenues. These reductions would impact not only NEMT services, but also other community mobility programs.

This research documents the initial experiences of Medicaid Transformation in North Carolina from the public transportation perspective using a case study approach that combines data from multiple sources and survey responses. The specific research questions addressed in this paper concerning the impact of Medicaid Transformation on coordinated public transportation are:

1. Will public transit be able to contract with private brokers?
2. Will public transit be offered trips from private brokers?
3. Are all transit systems experiencing the same impacts on trip volumes?
4. Are per trip invoices comparable between DSS and private brokers?
5. Do private brokers pay fully and on-time?
6. Do the private brokers offer trips that public transportation systems can accept?
7. Are public transit systems offered trips first by private brokers?
8. What comments did the transit systems enter into the survey?

Medicaid Non-Emergency Medical Transportation

Transportation to medical appointments and services is an essential feature of Medicaid, particularly for transportation disadvantaged populations, including low-income, seniors, non-White, and women (Edrington 2018, Eisenberg 2020; Starbird, 2019). Nationally, state Medicaid programs spend around $3 billion on NEMT annually; although this is small fraction of total Medicaid spending, there has been movement in the past decades to reduce these costs (Musumeci, 2016). The Deficit Reduction ACT (DRA) of 2005 led to an increase in states employing NEMT brokerages to meet these needs (Edrington, 2017).

As every state runs its Medicaid program independently, there is a wide range of NEMT systems as well. In 2014, a national survey of state NEMT services found 7 different NEMT models: in-house management; managed care organization (MCO), statewide broker, regional broker, in-house management and MCO, in-house management and regional broker, and MCO and statewide broker. Most of the statewide brokers are for-profit companies, often working in multiple states, while regional brokers are a mix of for-profit companies and local agencies

(public transportation, human services, etc.) (Edrington 2017). State Medicaid programs tend to negotiate a pre-set limit on much money private NEMT brokers will receive, a practice intended to encourage them to bring down their costs and schedule their trips as efficiently as possible, although overall costs may not be lessened (Adelberg, 2017).

Coordinated Public Transportation Prior to Medicaid Transformation

All 100 counties in North Carolina have some form of coordinated service for both the general public and human services agency passengers (Monast, 2018). Coordinated transportation systems are umbrella organizations that provide service to multiple human services agencies and, in many cases, the general public. By coordinating their efforts, human services agencies share the expense of capital and operating costs and therefore reduce the cost of individual trips (Burkhardt, 2012). Coordination also makes federal Section 5311 funds available to subsidize capital and operating costs in non-urbanized areas (Federal Transit Administration, 2014).

Section 5311 funds were designed to combine federal transportation money previously split into different programs and to improve general public transportation in rural areas (Monast, 2018). Accessing these funds was a primary impetus for developing coordinated community transportation systems and serving the general public. NCDOT receives more than $30 million in Section 5311 funds every year.

Before these services were coordinated in the early 1980's, human services transportation was provided by individual agencies operating separate fleets of vehicles for serving senior centers, nutrition sites, Medicaid customers, and other federally funded program recipients. Although only suggested for federal Section 5311 funding, locally coordinated human service

transportation plans are a requirement for being eligible to receive federal Section 5310 Elderly and Persons with Disabilities funds, so all 50 states plus the District of Columbia have coordination plans (FTA, 2022; National Center for Mobility Management, 2022).

According to the annual transit financial and service dataset, the NC Operating Statistics, Medicaid is the largest funder of human services agency transportation in the coordinated transportation model in North Carolina. As locally generated revenue, Medicaid funds serve as local matches for other federal and state funding programs. In Fiscal Year 2019, prior to the Covid-19 pandemic, 61 of the 80 (76%) coordinated public transportation systems provided Medicaid NEMT, serving almost 1.3 million trips, or 23% of the total trips provided. Medicaid contracts resulted in $21.5 million in revenues which was 21% of the total state, federal and local revenues for coordinated transportation providers. Table 8 shows the FY19 Medicaid statistics for the public transportation providers that served Medicaid trips. An average of 25% of their total revenue is derived from Medicaid services, with a minimum of 2% and a maximum of 68%. Medicaid revenue accounts for 42% of local revenue earned, which is important because local revenues are often used as local matches to federal and state grants. One transit system reported 96% of its local revenue was derived from Medicaid. The transit system average for the percent of Medicaid trips is 26%, with an agency minimum of less than 1% and maximum of 81%.

Table 8. Medicaid Statistics in FY19 for Transit Systems Providing NEMT (n=61)

Medicaid Revenue Percentage of Total Revenue (Federal + State + Local)	
Average	*25%*
Minimum	*2%*
Maximum	*68%*
Medicaid Revenue Percentage of Local Revenue	
Average	*42%*
Minimum	*4%*
Maximum	*96%*
Medicaid Trip Percentage of Total Trips	
Average	*26%*
Minimum	*0.2%*
Maximum	*81%*

Figure 4 displays the same data as Table 8, but as histograms with dashed lines indicating mean values.

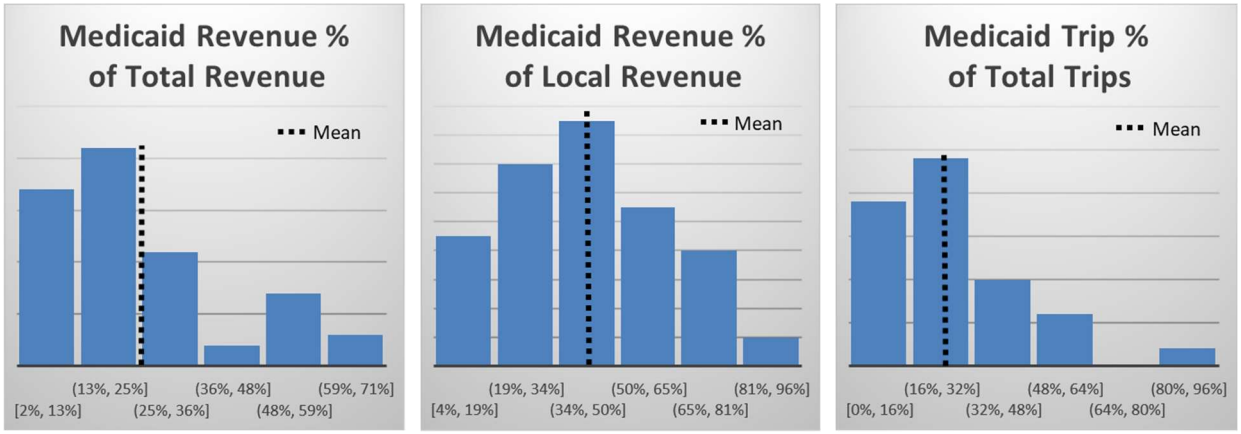


Figure 4. Histograms of Medicaid Statistics in FY19 for Transit Systems Providing NEMT

Providing Medicaid transportation tends to be more expensive than most human services agency contracts because of the service characteristics (Monast, 2018). Nutrition trips, for instance, typically involve providing regularly scheduled service to customers to the nearest nutrition sites and going to the same destination at the same time. Thus, it is easy to group

nutrition trips to provide more efficient and cost-effective service. On the other hand, Medicaid trips are more difficult to group because they tend to less-predictable, have both origins and destinations dispersed throughout the service area, and have times dispersed throughout the day.

Medicaid Transformation in North Carolina

In 2015, the North Carolina State Legislature enacted Medicaid Transformation with Session Law 2015-245 (General Assembly of North Carolina, 2015). On July 1, 2021, the North Carolina Department of Health and Human Services (DHHS) implemented the first phase of Medicaid Transformation which transitioned 1.6 million people from fee for service to NC Medicaid Managed Care (North Carolina Department of Health and Human Services, 2021), representing about 15% of the Medicaid non-emergency medical transportation (NEMT) trips. This transition introduced Prepaid Health Plans (PHPs) which are pre-determined per person rates intended to cover both health care needs and NEMT necessary to access those health care needs. The PHPs are administered by health insurance companies that utilize private, for-profit transportation brokers to distribute Medicaid trips to transportation providers. Previously, county Division of Social Services (DSS) agencies served as the sole transportation broker and the county-based coordinated public transportation providers were often the selected provider of these services. Phase 2 is the launch of Tailored Plans which will expand to include most of the remaining Medicaid beneficiaries and is expected to begin in December 2022 (North Carolina Department of Health and Human Services (1), 2022), which is when DSS will cease being an NEMT transportation broker.

NC DHHS issued contracts to five PHPs across the state as shown in Figure 4 (North Carolina Department of Health and Human Services (2), 2022). Four PHPs serve the entire state and one, Carolina Complete Health, is limited to regions 3, 4, and 5.

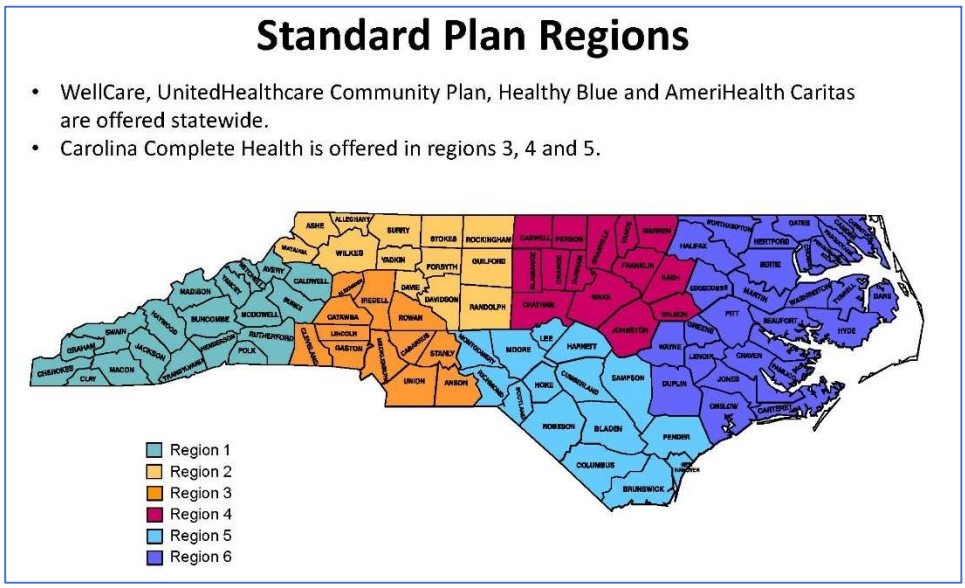


Figure 5. Prepaid Healthcare Plan (PHP) Regions

Three private NEMT brokers were introduced to the transit systems during the planning stage, ModivCare (then Logisticare), OneCall, and National MedTrans. National MedTrans exited the market after contract negotiations and software integration discussions had begun but prior to implementation because it was acquired by the company that became ModivCare (LogistiCare, 2020). During the study time period, three of the statewide PHPs and the regional PHP contracted with ModivCare and one statewide PHP (WellCare) contracted with OneCall to be the transportation broker (North Carolina Department of Health and Human Services (3), 2022). As of May 2022, OneCall exited the market and was replaced with MTM. During the initial phase, county-based DSS agencies continue to be the transportation broker for the majority of NEMT trips but phase 2 will eliminate DSS as an NEMT broker.

Public Transportation Concerns Prior to Medicaid Transformation

Prior to the implementation of NC Medicaid Transformation, public transportation providers were concerned the introduction of PHPs and private, for-profit transportation brokers would require significant changes in how NEMT is provided and possibly threaten the coordinated model. This section explores some of the major concerns which led to the development of a survey to track the trips, reimbursements, and comments monthly after the transition. The concerns, taken from a white paper written by the research team in 2018 (Monast, 2018), include:

- **Service Policies:** PHPs were expected to establish stringent service policies. To be able to coordinate trips among multiple agencies, many coordinated transportation systems require at least a one-day advance reservation. PHPs may reduce the reservation period or require real-time, on-demand service. Reducing the advance reservation period could decrease efficiency and increase costs. The PHP could refuse to reimburse providers for no shows and late arrivals.
- **Cost Reimbursement:** Coordinated transportation providers bill human services agencies for services a number of different ways; most using shared miles or hours (total service/revenue miles/hours times the rate divided by the number of passengers), which is effective for recouping all expenses. The PHPs' proposed billing model was expected to establish the reimbursement amounts before the trip is carried, based on the distance between origin and destination. Coordinated providers would need to understand how changes in the cost reimbursement structure impact other services. Transportation providers also need to be able to determine, on a trip-by-trip basis, whether the reimbursement amount adequately

cover costs – a calculation based on the ability to group service, deadhead miles/time, and other service requirements. If the coordinated transportation provider is not judicious in only providing service where the reimbursement amount meets or exceeds the cost, then private for-profit Medicaid transportation will be subsidized by other human services agencies, grant programs or local funds, reducing funds available for non-Medicaid passengers to access needed services.

- **Coordinated Providers Excluded from Medicaid Service:** If the coordinated transportation system is not selected to participate in Medicaid NEMT or cannot agree upon acceptable terms, the service being provided to the community will change. Public transportation providers with high levels of NEMT trips will be forced to restructure their service delivery models to constrain costs and increase efficiency. Their technology applications will also need to be re-evaluated to determine whether they are adequate for supporting these new service structures. Also, it is likely that the loss of Medicaid transportation will result in many coordinated providers being over-capitalized with vehicles and possibly technology, at least until new services are established.
- **Cross-Jurisdictional Service:** Regardless of which organizations provide Medicaid NEMT in the future, it is likely that future Medicaid transportation providers will be required to operate beyond the traditional service area boundaries that currently exist. Rather than dealing with a single transportation agency for each service area, the PHP or its broker will likely assign trips to the most cost-effective provider – which could be an operator from a different service area.

Data

The first phase of Medicaid Transformation began on July 1, 2021. The survey period spans from July 1, 2021 to December 31, 2021. The data are compiled from a transit agency survey, transit agency operating statistics, and directly from the largest private transportation broker (ModivCare). Survey results were combined with corresponding monthly public transportation service statistics for the study period and for prior years using the NC Operating Statistics of the respondents. NC Operating Statistics include monthly miles and hours by mode and trips by mode and trip funder, including Medicaid, general public, and/or other contract. Additional data on trip return rates (trips offered to the transit system but returned back to the broker) were provided by ModivCare, the private NEMT broker with the largest volume of trips. The researchers attempted to acquire NEMT claims data from NC DHHS to further analyze NEMT trips, but the request has not been fulfilled as of July 2022. The initial request was made in February 2022.

The survey was distributed to all public transportation providers and reminders to participate were sent by the researchers via the North Carolina Public Transportation Association. The completely voluntary survey was available online using SmartSheet software and contained questions related to each transportation broker (DSS, ModivCare, and OneCall) about the trips carried, funding amounts requested and paid, reasons for trip requests being returned, and qualitative comments. In total, 19 out of a potential 78 transit systems responded to the survey each month from July 2021 through December 2021. However, two systems reported zero NEMT trips before the transition, meaning there was no comparison and two systems did not carry any brokered NEMT trips. These four systems were removed, resulting in a sample of 15.

Transit systems in the analysis represent rural, suburban, and urban communities across North Carolina. As of 2022, there are 78 coordinated community transportation systems in the state, but not all provided NEMT services before and/or after Medicaid Transformation. Responding to the survey was optional and therefore self-selective and also required that surveys be submitted for each month, meaning six observations per site. With 15 complete responses, the response rate is at least 19%. Because of the diversity in system size and geographic locations, it is believed that the survey sample is representative of the state as it includes urban, suburban, and rural sites from the mountains to the coast.

Table 9 names the transit systems, county served, population (Tippett, 2021), geographic area (replacing Piedmont with Central for easier interpretation) (Secretary of State Elaine F. Marshall, Undated), and square miles (USA.com, Undated).

Table 9. Transit Systems Included in the Analysis

Name	County	Geography	Population	Square Miles
Alleghany in Motion	Alleghany	Mountain	10,888	235
Avery County Transportation	Avery	Mountain	17,806	247
CCATS	Carteret	Coastal	67,686	506
COLTS	Lee	Central	63,285	255
Duplin County Public Transportation	Duplin	Coastal	48,715	816
JCATS	Johnston	Coastal	215,999	791
Lenoir County Transportation	Lenoir	Central	55,122	401
Martin County Transit	Martin	Coastal	22,0312	461
Mitchell County Transportation	Mitchell	Mountain	14,903	221
OUTS	Onslow	Coastal	204,576	763
Rutherford County Transit	Rutherford	Mountain	64,444	564
Sampson Area Transportation	Sampson	Coastal	59,036	945
Transportation Lincoln County	Lincoln	Central	86,810	298
Union County Transportation	Union	Central	238,267	632
WAVE	New Hanover	Coastal	225,702	192

The survey collected data related to both private brokers. However, because ModivCare serves the 4 statewide PHPs while OneCall served the single regional PHP, over 85% of the private broker NEMT trips carried by public transportation were for ModivCare. Because this

analysis is observing the impact of Medicaid Transformation on public transportation, the data for the private brokers are aggregated and not presented by company. The logic behind this presentation of facts, supported by the experiences of public transportation during NC Medicaid Transformation, is private for-profit vendors may be replaced at any time, so analyzing differences between the companies is not informative until some sort of stability is observed.

Descriptive statistics of NEMT trips by transit system are shown in Table 10.

Table 10. NEMT Trips Served by Transit System, July 2021 to December 2021

Transit System	Total NEMT Trips	DSS Trips	ModivCare Trips	OneCall Trips	Private Broker Total	Private Broker Percent
Alleghany in Motion	1,172	1,103	66	3	69	6%
Avery Count Transportation	573	456	93	24	117	20%
CCATS	3,846	3,233	558	55	613	16%
COLTS	4,981	4,668	291	22	313	6%
Duplin County Public Transportation	4,635	4,262	225	148	373	8%
JCATS	19,039	16,486	2,176	377	2,553	13%
Lenoir County Transit	10,270	9,513	755	2	757	7%
Lincoln County	5,273	5,039	179	55	234	4%
Martin County Transit	5,031	4,707	309	15	324	6%
Mitchell County Transportation	1,344	1,168	167	9	176	13%
OUTS	12,744	10,627	1,743	374	2,117	17%
Rutherford County Transit	4,514	3,676	647	191	838	19%
Sampson Area Transportation	7,118	6,227	753	138	891	13%
Union County Transportation	5,638	4,980	618	40	658	12%
WAVE	9,826	9,779	0	47	47	0.5%
Total	**96,004**	**85,924**	**8,580**	**1,500**	**10,080**	**10%**

Analysis

The analysis is divided into specific research questions developed from the pre-implementation concerns of the coordinated public transportation providers and the availability of data and include:

1. Will public transit be able to contract with private brokers?

2. Will public transit be offered trips from private brokers?
3. Are all transit systems experiencing the same impacts on trip volumes?
4. Are per trip invoices comparable between DSS and private brokers?
5. Do private brokers pay fully and on-time?
6. Do the private brokers offer trips that public transportation systems can accept?
7. Are public transit systems offered trips first by private brokers?
8. What comments did the transit systems enter into the survey?

Each section has a conclusion statement that summarizes the findings from the analysis. There is a separate conclusion section that summarizes the findings, followed by a robust discussion.

1. Will Public Transit Systems be able to Contract with Private Brokers?

Public transportation providers initially expressed concerns regarding whether or not they could agree upon acceptable contract terms with the private brokers. In 2019, prior to Medicaid Transformation and the COVID-19 pandemic, 70 out of 78 (90%) coordinated public transportation systems contracted with DSS and these contracts continued after Medicaid Transformation. During the study period, only 54 (69%) of the coordinated public transportation systems contracted with at least one of the private brokers. Thus, 16 transit systems were unable to establish agreeable contractual terms with the private brokers, a 23 percent reduction (Figure 6).

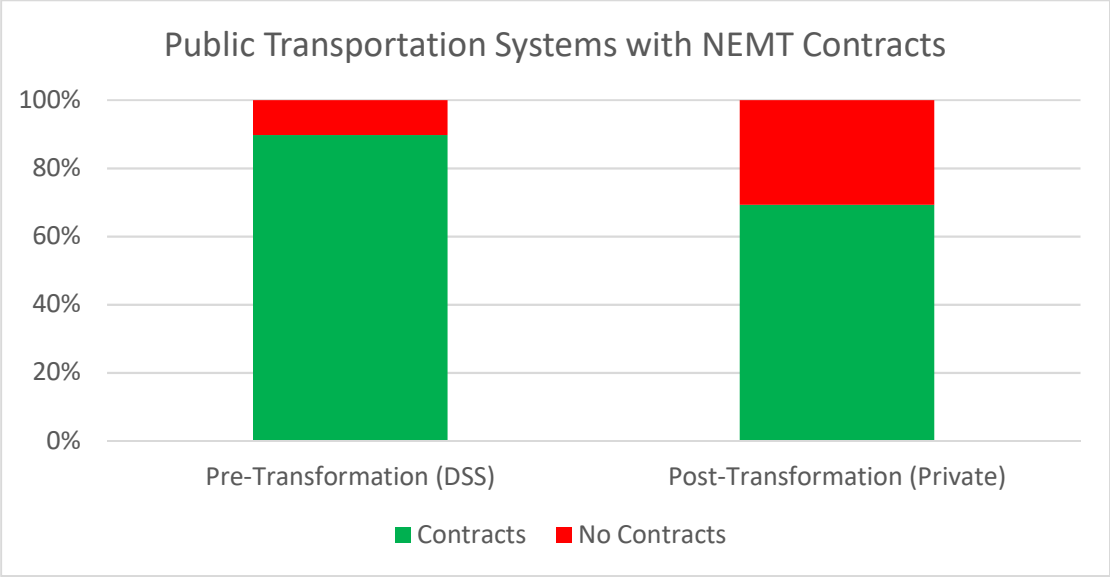


Figure 6: Public Transportation Systems with NEMT Contracts Pre- and Post- Medicaid Transformation

Conclusion: Nearly 25% of the transit systems with DSS contracts were unable to agree on terms with the private brokers.

2. Will Public Transit Systems Receive Trips from Private Brokers?

Transit agencies also expressed concern that private brokers would not offer trips to public transportation at the same volumes they received prior to Medicaid Transformation. To determine how trip volumes have changed since NC Medicaid Transformation, prior year data from the 2019 and 2020 NC Operating Statistics is combined with the FY21 survey data. Overall, the total number of NEMT trips provided after Medicaid Transformation are greater than those provided for the same period in 2020 when vaccines were not widely available and significant COVID-19 precautions were still in place. But, as is shown in Figure 7, total trips are still well below levels prior to COVID-19 (blue line) The dip in September 2019 is due to a major hurricane that severely impacted the number of trips provided.

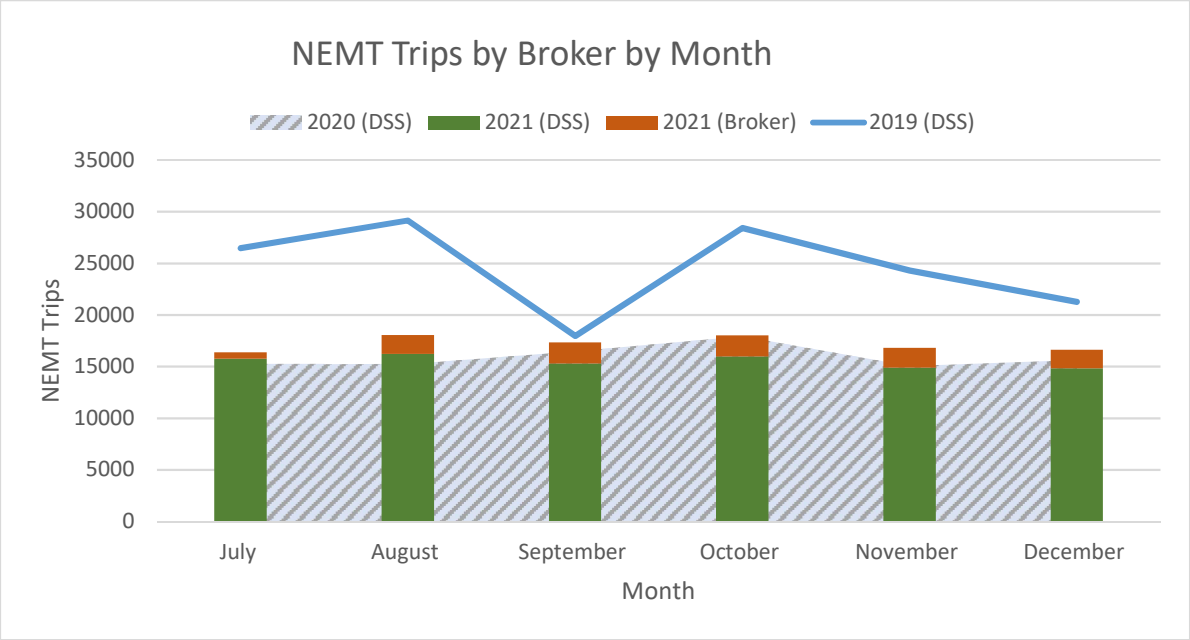


Figure 7. NEMT Trips by Broker by Month

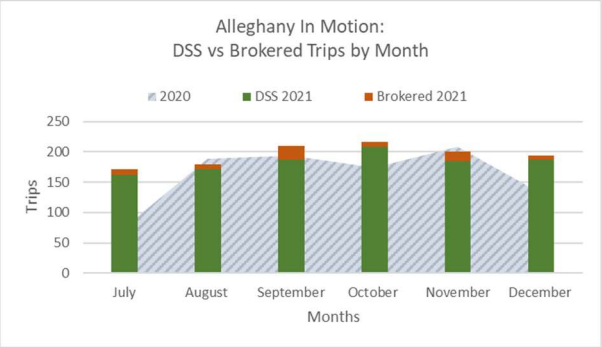
Figure 7 also shows growth in NEMT trips served for the private brokers between July and August 2021. Upon the initial rollout in July, public transportation systems received few trips from the private brokers. The North Carolina Public Transportation Association was able to secure a commitment from the PHPs and private brokers that public transportation should be given the 'right of first refusal' for NEMT trips toward the end of July 2021. It is possible this policy commitment had an impact on trips offered to public transportation from July to August or it could be that a new sense of urgency for all parties resulted in resolving contracting issues and data sharing agreements. An analysis about the 'right of first refusal' is found later in this document.

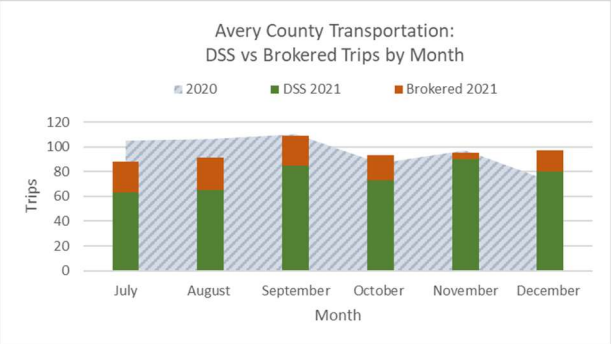
It is difficult to determine if transit systems would have returned to 2019 NEMT levels due to a myriad of factors, including NC Medicaid Transformation but also behavioral changes and practices such telemedicine. The researchers attempted to gather additional data from NC DHHS on all NEMT services, but the data request had not been fulfilled as of June 2022.

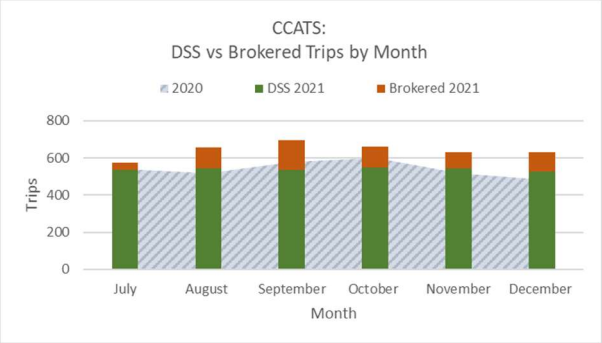
Conclusion: Total NEMT trips after Medicaid Transformation are slightly higher than 2020, but well below 2019 levels.

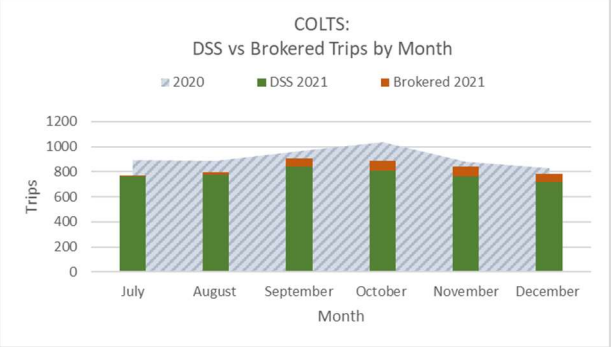
3. Are all transit systems experiencing the same changes in trip volumes?

Figure 6 addressed transit systems in aggregate and shows that 2020 and 2021 NEMT trips were roughly comparable. Similar charts were created for each transit system to determine if individual transit systems experienced similar changes in trip volumes between 2020 and 2021 (Figure 8). All trips in 2020 originated from DSS whereas 2021 trips originate from DSS and the private brokers.


Alleghany In Motion:
DSS vs Brokered Trips by Month
2020
DSS 2021
Brokered 2021
Trips
250
200
150
100
50
0
July
August
September
October
November
December
Months


Avery County Transportation:
DSS vs Brokered Trips by Month
2020
DSS 2021
Brokered 2021
Trips
120
100
80
60
40
20
0
July
August
September
October
November
December
Month


CCATS:
DSS vs Brokered Trips by Month
2020
DSS 2021
Brokered 2021
Trips
800
600
400
200
0
July
August
September
October
November
December
Month


COLTS:
DSS vs Brokered Trips by Month
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DSS 2021
Brokered 2021
Trips
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1000
800
600
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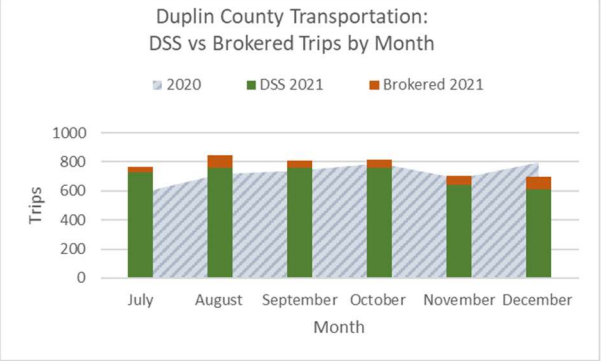
0
July
August
September
October
November
December
Month


Duplin County Transportation:
DSS vs Brokered Trips by Month
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DSS 2021
Brokered 2021
Trips
1000
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400
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July
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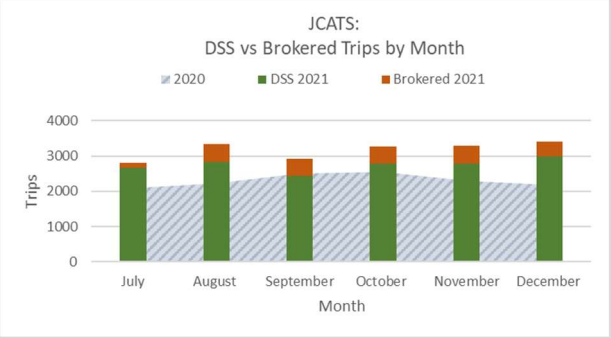
November
December
Month


JCATS:
DSS vs Brokered Trips by Month
2020
DSS 2021
Brokered 2021
Trips
4000
3000
2000
1000
0
July
August
September
October
November
December
Month


Lenior County Transportation:
DSS vs Brokered Trips by Month
2020
DSS 2021
Brokered 2021
Trips
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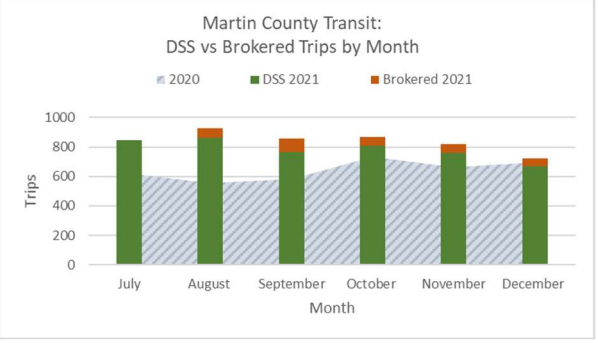
2000
1500
1000
500
0
July
August
September
October
November
December
Month


Martin County Transit:
DSS vs Brokered Trips by Month
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DSS 2021
Brokered 2021
Trips
1000
800
600
400
200
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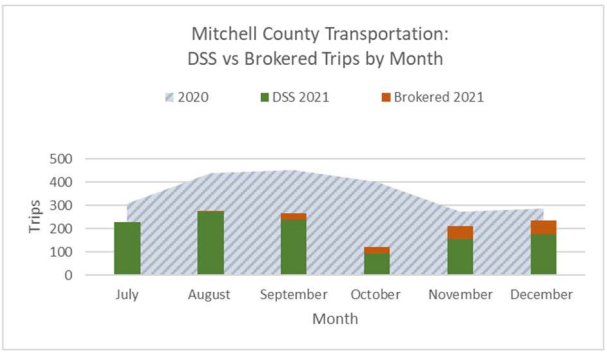
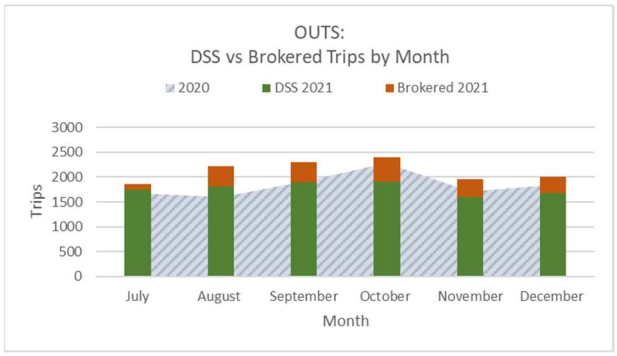
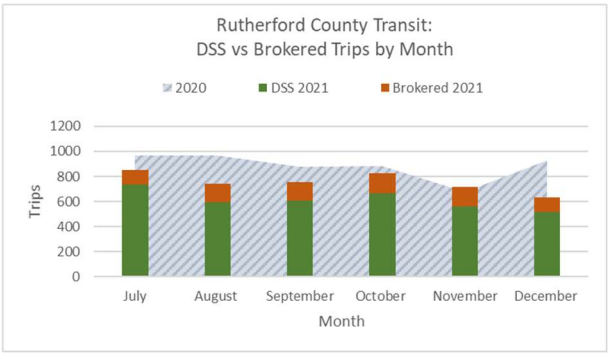
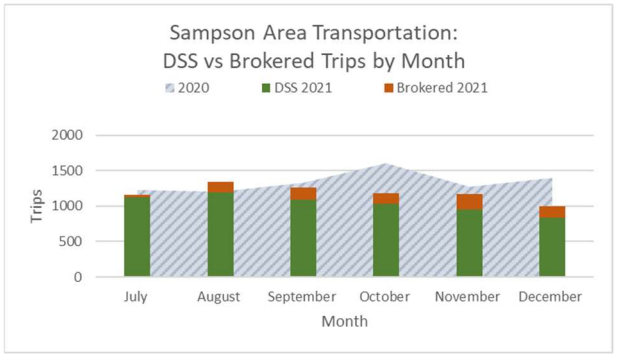
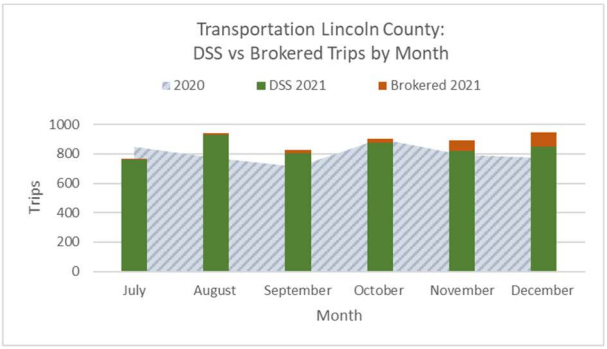
July
August
September
October
November
December
Month

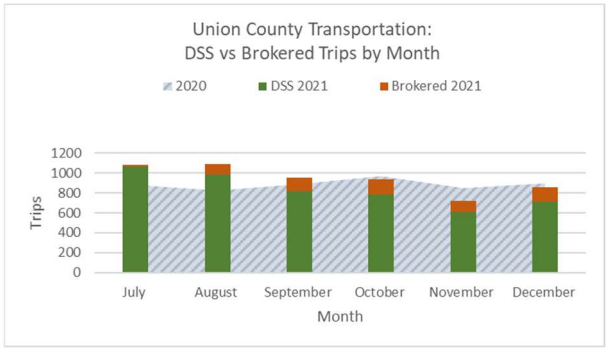












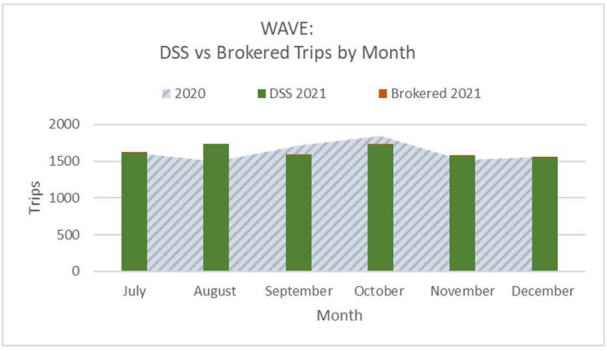


Figure 8. Brokered Trips by Transit System

The charts in Figure 8 show that some transit systems, such as JCATS and Martin County Transportation, have exceeded 2020 NEMT trips from DSS alone. The addition of brokered trips means JCATS is well above 2020 levels. However, COLTS and Mitchell County Transportation, as examples, have not exceeded 2020 levels in any month, even with the brokered trips. For these and other transit systems with lower NEMT volumes, do these trips still exist, and if so, who is carrying them?

Conclusion: The impact of Medicaid Transformation on transit systems is uneven.

4. Are per trip invoices comparable between DSS and private brokers?

This research question addresses the concern that allowable billing rates from private brokers may be lower than DSS rates. To fully answer whether per trip invoices from DSS and the private brokers are comparable, it is necessary to understand whether trip characteristics are also comparable, such as pickup/drop off windows, the ability to load multiple passengers on the vehicle, deadhead, wait time, trip origins and destinations, etc. on an individual trip-level and that the administrative burden is equivalent. Without access to the trip requirements and the actual trip data, a direct comparison of per trip invoices requires the assumption that the trips are comparable between DSS and the private brokers. The assumption of equivalency is made even though, anecdotally, the transit systems claim that pickup and drop off windows are difficult to negotiate with the brokers, the administrative burden is greatly increased, and grouping trips is more difficult. If true, these conditions would result in an expectation of higher per trip invoices to the private brokers as compared to DSS. However, the opposite outcome has been observed.

Over the six-month study period, DSS was invoiced a total of $31.08 per trip whereas the private brokers were invoiced $29.94 per trip, a difference of $1.14 per trip, or 4% lower than DSS. Figure 9 shows the invoice amounts per trip by month and indicates that invoices sent to DSS were higher in July, September, and October 2021, whereas the invoices sent to both sets of brokers were similar in August, November, and December 2021.

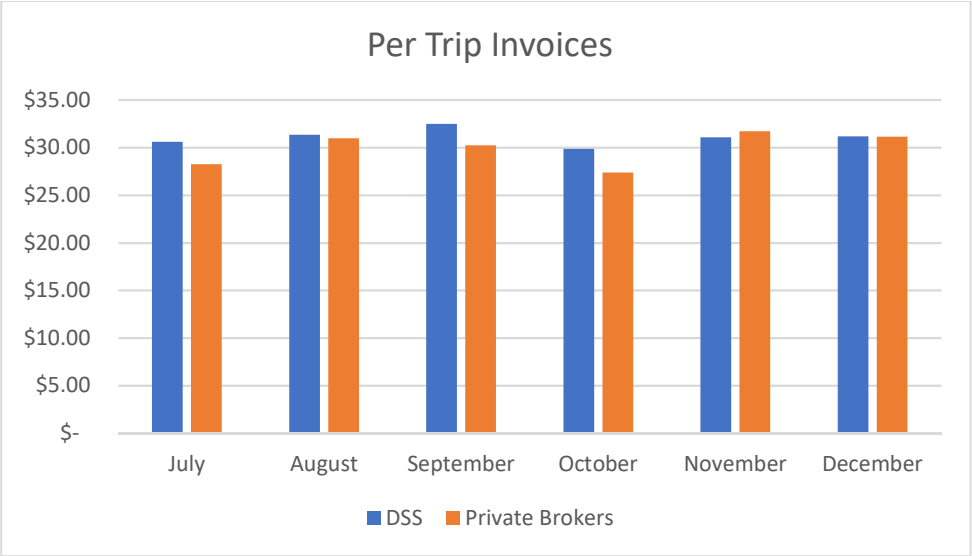


Figure 9. Per Trip Invoices by Broker

Although a 4% difference in invoice rates may seem trivial, public transportation received $21.5 million in Medicaid contracts in Fiscal Year 2019. Assuming all other trip and service characteristics are equal, a 4% decrease in revenues after Medicaid Transformation is fully implemented would result in a loss of $850,000.

Conclusion: The per trip invoices to the private brokers are lower than for DSS.

5. Do Private Brokers Pay Fully and On-Time?

Another primary concern from the public transportation providers was whether the private brokers would be as reliable at paying invoices as DSS. During the study period, public transit systems invoiced DSS for $2.8 million and DSS paid $2.65 million. Thus, DSS paid 94% of what they were invoiced but 6% was unpaid, possibly because of disputes concerning eligibility and services provided (Figure 10). Meanwhile, private brokers were invoiced $300,000 and paid $271,000, or 89%.

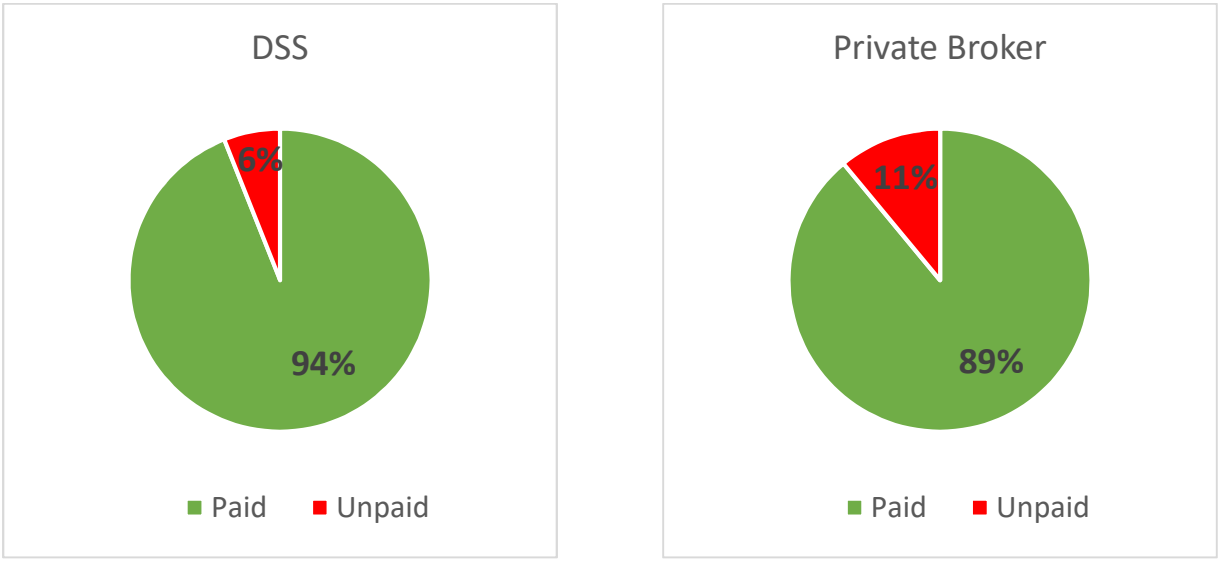


Figure 10. Invoice Amounts Paid and Unpaid by Broker

Table 11 shows the percent of claims paid by month in 2021 compared to invoice amounts for DSS and the two private brokers. All brokers had difficulty paying during the first month of the transition causing underpayments that were mostly resolved in later months. However, except for September, DSS was consistently a more reliable payer than the private brokers. And, being greater than 100%, the October DSS percent paid likely indicates a catch-up

payment from September which could be the result of the federal fiscal year ending in September.

Table 11. Percent of Claims Paid by Month

Month	DSS Percent Paid	Private Broker Percent Paid
July	84%	67%
August	96%	88%
September	89%	95%
October	104%	95%
November	98%	96%
December	91%	79%
Total	**94%**	**89%**

The data sharing relationship between the private brokers and transit systems may improve over time, which could result in greater accuracy in developing invoices and issuing payments. But, for now, DSS is a more reliable payer than the private brokers.

Conclusion: DSS is more reliable at paying invoices on-time and in-full than the private brokers.

6. Do the private brokers offer trips that public transportation systems can accept?

Even in cases where public transportation has the right of first refusal, just because a trip is offered does not mean it is a trip that can be served. Transit systems need to consider a plethora of factors when determining whether to accept a trip, including pickup/drop off times, pickup/drop off windows, type of vehicle, attendants/guests, the ability to load multiple passengers on the vehicle, deadhead, wait time, trip origins and destinations, and other features.

All of these factors must be compared against the expected reimbursement the transit system will receive. If all of the factors do not add up, the transit system returns the trip to the broker and the broker will find another provider to serve the trip.

It is not easy for the transit systems to compile data on which trips are returned because this function occurs in the private broker's software portal, meaning returned trips do not exist in the transit system's software. Therefore, the data analyzed in this section were provided by ModivCare, the largest private transportation broker. The data are for the entire state, not just the survey sample sites, and is from December 2021.

According to ModivCare's data, public transportation providers were offered around 10,000 trips statewide, with 36% of the trips offered being returned and not served by coordinated public transportation systems. Private providers, meanwhile, were offered around 22,000 trips and returned 13% (Table 12). The characteristics of the trips offered to the providers are unknown, as is whether the private or public transportation provider was offered the trip first. Figure 11 displays these results in pie charts.

Table 12. Trips Offered, Carried, and Returned by Provider Type

Provider Type	Trips Offered	Trips Carried	Trips Returned	Return Rate
Public Transportation	10,093	6,421	3,672	36.4%
Private Providers	21,696	18,890	2,806	12.9%
Total	**31,789**	**25,311**	**6,478**	**20.4%**

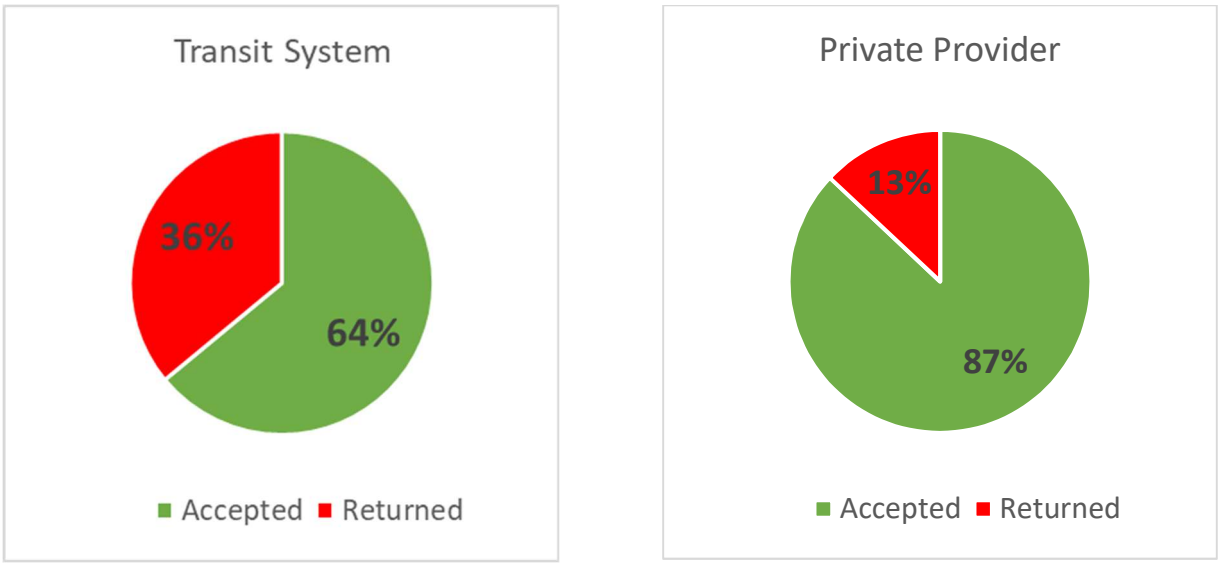


Figure 11. December ModivCare Acceptance and Return Rates for Public and Private Providers

A return rate of 36% means that for every 100 trips assessed to the transit system, they determined 36 of these trips could not be served because of reasons described below. This results in a higher administrative burden relative to DSS brokered trips because each trip offered is evaluated by a staff person. This also results in a financial burden because the transit systems use limited resources to return trips and they are not reimbursed for this resource use.

The transit survey asked to select the reasons why public transportation returned trips to the brokers. Multiple selections were possible, but the number of trips for each reason was not collected because of the recordkeeping burden on the transit systems. Figure 12 shows the primary reason for returned trips is the trips are outside of the transit system's service area (81%). Like the coordinated public transportation systems, DSS is county-based so staff would only be aware of trips associated with clients assigned to the county based on home address.

Being offered trips for customers residing outside of the service area is new phenomenon for the transit systems. The second most frequently cited reason, 73 percentage points lower, is the trip is outside of the service time.

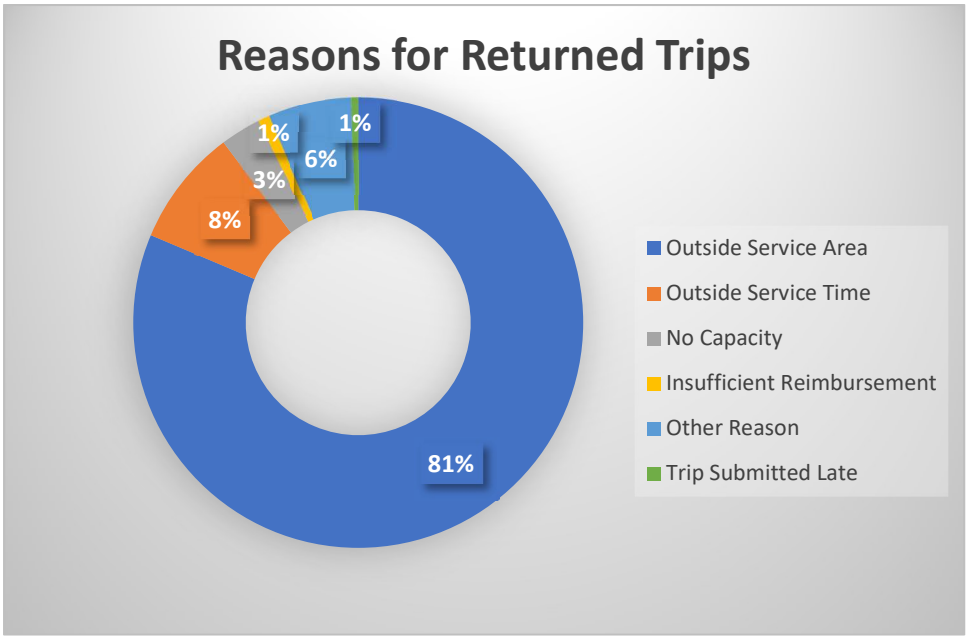


Figure 12. Reasons for Returned Trips from Transit Systems

Conclusion: Transit systems reject over 1/3 of the trips offered to them by private providers.

7. *Are public transit systems offered trips first by private brokers?*

As previously noted, the North Carolina Public Transportation Authority worked with the PHPs and private brokers in late July 2021 to forge an agreement that public transportation would be given the 'right of first refusal'. The researchers attempted to acquire NEMT claims data from DHHS but have been unsuccessful as of July 2022. The lack of data transparency means it is difficult to know exactly how many trips could have been offered to public transportation.

However, according to ModivCare's data in Table 12, public transportation systems were offered around 10,000 trips in December 2021 while 25,000 trips were carried, meaning at least 15,000 trips were not offered to the transit systems first. In the most optimistic scenario where each trip offered to the transit system was offered to them first, transit systems are given the 'right of first refusal' for 40% of the trips. If, alternatively, private providers were sent the trips first, private providers received the 'right of first refusal' for 87% of the trips.

Thus, it is clear that public transportation is not being offered all trips first, at least as of December 2021. It is possible the private brokers understand the capabilities of public transit systems and do not offer trips they could or would not serve, which seems unlikely considering the prevalence of returned trips outside of the service area and operating hours of the transit system. Thus, the 36% return rate by public transportation indicates that the private brokers and public transportation have not succeeded in defining and/or communicating which trip types are acceptable.

Conclusion: Transit systems are not offered most trips first by private brokers.

8. What comments did the transit systems enter into the survey?

The survey allowed transit systems to enter comments using free text. A total of 47 comments were entered over the 6-month period. These comments were categorized by topic and shown by frequency in the pie chart below (Figure 13).

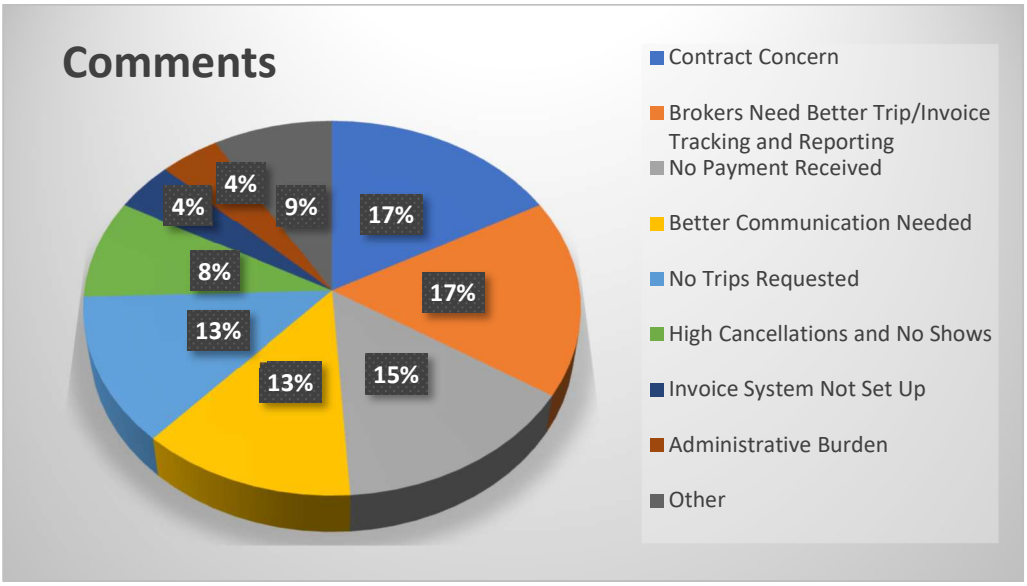


Figure 13. Transit System Comments

Conclusion: Public transit systems expressed concerns about numerous topics related to Medicaid Transformation and NEMT provision.

Conclusions

After the first 6 months of the initial phase of Medicaid Transformation in North Carolina, some of public transportation's fears going into the project have been validated while others have not. In many cases, public transportation was included as an NEMT provider by the private brokers and it was even agreed upon to give public transportation the 'right of first refusal'. However, this agreement has not reliably translated into action. Individual transit

agencies are experiencing disparate effects, with some seeing an increase in NEMT trips and others experiencing decreases.

The conclusions from the analysis section are summarized below and discussed in the next section.

1. *Nearly 25% of the transit systems with DSS contracts were unable to agree on terms with the private brokers.*
2. *Total NEMT trips after Medicaid Transformation are slightly higher than 2020, but well below 2019 levels.*
3. *The impact of Medicaid Transformation on transit systems is uneven.*
4. *The per trip invoices to the private brokers are lower than for DSS.*
5. *DSS is more reliable at paying invoices on-time and in-full than the private brokers.*
6. *Transit systems reject over 1/3 of the trips offered to them by private providers.*
7. *Transit systems are not offered most trips first by private brokers.*
8. *Public transit systems expressed concerns about numerous topics related to Medicaid Transformation and NEMT provision.*

Discussion

Medicaid Transformation in North Carolina, even with its limited roll-out in Phase 1, had a measurable impact on the coordinated public transportation providers across the state that provide general public and life-sustaining transportation.

With the disruption of the Covid-19 pandemic and lack of comprehensive NEMT trip data from NC DHHS, it is not possible to determine how many trips would have gone to the public transportation providers without Medicaid Transformation. Overall, trips are higher in the

last six months of 2021 than the same months in 2020, but some transit systems remain below their 2020 level. Plus, because Covid-19 vaccines were not available, the last six months of 2020 is likely not a good benchmark for how many trips should be expected in 2021. Medicaid trips have historically been the backbone of many public transit systems in North Carolina. When NEMT trip volumes decrease for public transit, overall community mobility may also decrease because transit systems do not have the demand or financial capacity to send vehicles across their service areas at different times or to long-distance medical facilities.

Even if private broker trip volumes are high, invoices sent to private brokers are 4% less per trip than DSS and invoice payments rates are 5 percentage points lower for private brokers in the first six months after Medicaid Transformation. When these two hits on revenue are combined, it means transit systems will either need to cut expenses or generate revenues from other funders to cover losses associated with serving NEMT trips from private brokers. It is unlikely that expenses for NEMT services can be cut because the service rules of the private brokers do not allow much flexibility for moving trips to allow for grouping and more efficient service. Thus, it is likely that other funders such as Area Agencies on Aging, local government funds, state, or federal funds will need to contribute more per trip to make up for the loss of funding provided by private for-profit NEMT brokers.

After Medicaid Transformation is complete in December 2022, assuming the observed patterns remain, the difference between DSS and private broker payments are expected to result in an annual loss of $1.1 million to public transportation because of unpaid invoices based on FY19 funding levels (pre-COVID). This number is in addition to the $850,000 decrease in bills allowed to be sent to the private brokers, resulting in a total potential annual loss of close to $2

million annually to North Carolina's public transportation industry, or 9% of their Medicaid revenue.

Even more important than the loss of $2 million in operating revenue is the loss of $2 million in contract revenue that can be used to match federal grants. For example, the Federal Transit Administration assists with capital funds for vehicles and other equipment at a rate of 80% Federal and 20% local. Thus, the loss of $2 million could result in transit systems being unable to access an additional $8 million in Federal funds, for a total loss of $10 million per year unless matching funds are available from other sources.

Public transit systems in North Carolina are accustomed to dealing with government entities which are consistent and do not profit from the business relationships. The introduction of private for-profit transportation brokers results in the introduction of competition. Competition means every transaction is relational, where the brokers will send trips to the provider most likely to generate a profit. Thus, historic trends from a private NEMT broker may not indicate future trends. If a new private transportation provider enters a market, public transportation may experience sudden and drastic decreases in NEMT business. If the private provider exits the market, the public provider may experience the same types of increases. If providers suddenly enter and exit the market, public transit systems will face wide swings in Medicaid trip volumes and revenues and non-Medicaid services will likely be impacted.

As Medicaid Transformation was struggling to be implemented in July 2021, earning a commitment from the PHPs and private brokers for public transportation to have the 'right of first refusal' was important for the public transportation industry and making that commitment was likely an important show of good faith effort from the PHPs and private brokers to NC DHHS. However, the data clearly show that, at least as of December 2021, this commitment was

not being honored because a maximum of 40% of the trips were offered first to public transportation. It could be that the private brokers did not fully make or stick to the commitment or that they learned over the ensuing months what trips public transit would accept and adjusted, an unlikely conclusion since public transportation returned 36% of the trips offered in December. A commitment to continuing a robust 'right of first refusal' program requires some confidence that the trips will be accepted. If the operational and payment terms are unacceptable to the public transportation systems and this is known, the trips will be refused which only creates delay and administrative burden for all parties. The 'right of first refusal' in itself should not be the goal. Instead, the goal should be the 'right of first refusal' for reasonable trips, meaning trips that fit into the existing service delivery model of the public transportation systems without consuming an unacceptable amount of resources and public subsidy to benefit the private for-profit brokers.

Even if public transportation systems form mutually beneficial relationships with the current private NEMT brokers, the short history of these brokers in North Carolina has shown that their relationships with PHPs is also a cause for upheaval. National MedTrans was one of the three brokers involved with the substantial planning efforts for the Phase 1 rollout of Medicaid Transformation, only to be acquired and replaced by ModivCare before implementation. OneCall survived through the planning phase and operated for ten months before opting out and being replaced by MTM. Changing transportation brokers has impacts on the Medicaid beneficiaries, but also requires substantial effort and expense for the transit systems in terms of the administrative burden to develop a new contract but also to learn a new software program that may differ greatly from the previous version.

Finally, the qualitative experiences of public transportation systems with Medicaid Transformation should continue to be collected by the State, the PHPs, and the NEMT brokers. Public transit providers are in daily contact with the Medicaid beneficiaries and have firsthand knowledge of their concerns. The quantitative data is important, but the State, PHPs, and NEMT brokers should have a system in place to collect information that is not being adequately measured through quantitative processes.

In summary, the long-term relationship between public transportation systems, private brokers, Prepaid Health Plans, and NC DHHS is still being formed. The initial experiences, however, show that public transportation providers are likely to have difficulty maintaining positive working relationships with private NEMT brokers unless something changes. There are many actors involved and many moving parts, making it difficult to predict where the relationship will settle.

Further research needs to be conducted as the next phase of Medicaid Transformation is unveiled in December 2022. The data collection process for this research should be repeated for the next few years to further understand the impact of Medicaid Transformation on overall access to healthcare and other essential destinations, especially in rural areas, and the overall health of public transportation. In addition to tracking and reporting on the aggregate trends, future research should explore whether spatial, demographic, or other characteristics explain the uneven impacts experienced by the transit systems.

CHAPTER 4: LOCATING AND COSTING CONGESTION FOR SCHOOL BUSES AND PUBLIC TRANSPORTATION

Introduction

Roadway congestion creates delays and increased costs for all roadway users, including buses. When buses are subjected to congestion, operating and capital costs increase, travel time reliability decreases, and the overall competitiveness and attractiveness of these modes decreases. This research integrates three large datasets to create a practitioner tool that allows transportation planners and engineers to model the relationship between traffic flow and congestion data (via RITIS) with public transportation (GTFS) and school travel data (Edulog). This practitioner tool will allow for the spatial identification of congestion impacts affecting public transportation and school buses, along with estimates of the costs incurred by these modes resulting from congestion. This methodology will allow practitioners to prioritize locations where treatments will be the most cost-effective and impactful.

Two different sites were chosen for comparison: Pinellas County, FL, a populous, primarily urban county with multiple distinct municipalities and Durham County, NC, a less—populous county with a centralized core that draws passengers from suburban and rural areas on its edges. Both counties have transit agencies and school districts that utilize the appropriate software packages.

By combining these three datasets, the research team was able to determine when and where publicly-funded transportation vehicles are operating and to estimate the delay experienced by each vehicle. The delay costs were then calculated both temporally and spatially,

allowing for identification of locations and times where mitigation strategies may be most appropriate. The complete, peer-reviewed report was published in May 2022 (Monast et al, 2022).

Background

The southeastern United States is experiencing rapid population growth in cities and towns that historically have little public transportation infrastructure. For instance, Florida and North Carolina ranked among the top 4 states in the number of new residents during a one-year period ending July 1, 2019 (Tippett, 2020). Congestion is a major issue for commuters in the United States. It is estimated that the average United States commuter wastes $763 annually ($85 billion yearly, as a nation) on congestion (United States Department of Transportation, 2019). Much of this cost to commuters can be relieved via public transit. For example, it is estimated that the Los Angeles Transit System saves the city $1.2 to $4.1 billion every year (Anderson, 2014).

Along with congestion increases, parents and students have more choices about which schools to attend which can increase travel times and lead to mode shifts from school buses to automobiles. Parents who drop off children at schools instead of having the students ride school buses contribute to morning peak hour traffic, as well as congestion around schools (La Vigne, 2007).

With this growth and travel behavior changes comes increased travel times and delays on the local roadway infrastructure. Weisbrod, Vary, and Treyz found that, “congestion can actually shrink business market areas and reduce the scale economies” (2003). Therefore, it is imperative that urbanized areas implement efficient transportation planning practices so that urban areas can manage growth and, in turn, reduce vehicle miles traveled (VMT), recurring congestion, and

travel times. Specifically, public and school transportation planning officials need to be equipped with tools to understand when and where their system is subject to congestion and understand how much that congestion costs.

When public transit services and school transportation are slowed down, or stopped in some cases, revenue miles start to drastically decrease while operational costs continue to rise. This effect correlates to the transportation system losing money and reducing efficiency, possibly resulting in a reduction of service. Additionally, if the more affluent portion of the community has the choice to sit in congestion on a public transit vehicle versus their personal vehicle, they will likely choose the comfort of their personal vehicle. The congestion that public transportation systems face does not encourage new ridership and therefore increases a car-centric mindset amongst the community.

School buses are also another factor to consider when looking at population growth and congestion. With the rapid increase in population, in conjunction with the expansion of schools, school choice, a continuation of suburban sprawl, and traffic congestion, public school buses are having to pick up their students upwards of 60 minutes before the bell time. According to the Institute for Transportation Research and Education's (ITRE) Transportation Information Management System (TIMS) group, North Carolina's earliest morning pick-up time for children riding the bus has fluctuated by nearly 30 minutes since 2010 (TIMS, 2017). Various studies have been conducted to show that this is an extreme detriment to the health of the next generation. As TIMS highlights in its own 2016-2017 North Carolina statewide report, "an early pickup might present a student with a particularly challenging start to the day" (2017). Studies show that younger students are particularly impacted; according to a study conducted by Deborah A. Temkin, et al. (2018), "Seventh and eighth grade students with later start times have

significantly longer sleep durations and less daytime sleepiness than do similar students with earlier start times."

Implications of congestion are widely seen across all avenues of urban planning, economics, and personal health. Common methods of dealing with congestion- building larger freeways and implementing congestion pricing, are not a viable solution because transit and school vehicles travel on secondary roads. Instead, transit agencies, municipalities, and counties need to be equipped with a reliable tool to understand: a) where congestion is occurring in their area; and b) how much that congestion costs in operational and capital funds to the public and school transportation services. Once these hotspots and costs are identified, proper solutions can be implemented in order to mitigate these delays.

Literature Review

What Causes Congestion

Congestion is defined as high traffic volumes which alter the quality of service for transportation systems (Sweet, 2011). This study focuses on recurrent congestion, which is congestion caused by increased vehicle travel at peak times. Recurrent congestion differs from non-recurrent congestion, like construction and bad weather, because it is more consistent.

Recurrent congestion can be caused by an increase in the number of residents using personal vehicles on limited capacity roadways. This happens when traveling by personal vehicle is seen as the most desirable option. Increased use of personal vehicles can be exacerbated by an increased rate of car ownership and a lack of appropriate roadway pricing. According to the Institute of Transportation Studies, congestion occurs because roadways are free to use, and inadequate pricing often leads to exploitation of the resource.

In an effort to avoid congested roadways, users can either elect to switch departure times to avoid peak hours of traffic or to take different routes to the same destination (Sweet, 2011). Consequently, the impact of traffic congestion is not confined to only the major roads. The travelers' effort to avoid delays results in an associated delay on smaller surrounding roads (Anderson, 2014).

School travel is another cause of congestion. School pick up and drop off explains 10-15% of peak motor vehicle trips (McDonald, 2005) as parents drop off and pick up their kids, resulting in an additional 4 trips per day (La Vigne, 2007). McDonald (2005) states that only 13% of children walk or bike to school, down 29% since 1969. This can be explained by a growth in car ownership/use in combination with urban sprawl which increases the distance needed to travel for school. As distance to school increases, six-times less children are reported as walking. Further, miles traveled, system cost and air pollution are reported as 2.5 times higher (Victorian Transport Policy Institute, 2018).

School related congestion is also caused by the perception of risk related to walking and biking. Parents are less willing to allow their child to travel alone (La Vigne, 2007) for fear of kidnappings and traffic accidents. Even when students live within a walking distance to school some parents consider walking and biking to be dangerous. The perception of danger can be related to the high volume of vehicles traveling around the school or the erratic behavior of drivers who are frustrated by the delay. Regardless of the reason, risk discourages children from walking and biking and forces parents to drive their children to school instead. This exacerbates the congestion problem around schools (La Vigne, 2007).

Strategies for Intervention

Although researchers agree that congestion is an issue which must be addressed, the appropriate measures to do so are contested. Traditionally, expanding roadways was used to reduce congestion by increasing capacity. But this is not an effective long-term solution (Sweet, 2011). An alternative to roadway expansion is subsidizing public transit. This is a publicly supported method to reduce congestion (Anderson, 2014; Parry & Small, 2009). The idea is to capture drivers who want to avoid delays by offering more frequent and affordable public transportation (Anderson, 2014). This would remove personal vehicles from traffic and consequently reduce congestion (Duy, 2018).

Some researchers are uncertain to what degree public transit reduces congestion. Particularly because mass transit makes up such a small share of total trips (Nelson, 2007; Beaudoin, 2018). Further, researchers believe there is latent demand to travel by personal vehicle (Beaudoin, 2017). This implies that transferring personal vehicle users to public transit would only induce other drivers to take their place on the roadways (Beaudoin, 2017). Because of this, adding public transportation is considered effective only in the short run because new drivers would enter the roadways and increase congestion (Anderson, 2014; Parry, 2009). Researchers argue for a combination of mass transit and congestion pricing (Beaudoin, 2018).

Adding busing is considered to reduce congestion related to school travel. Instead of public transportation, the focus is on adding school buses. This is thought to remove parent drivers by offering an attractive alternative. Besides adding busing, School Transport Management strategies offer a list of methods for intervention. The goal is to encourage parents, students, and staff to reduce automobile trips by using alternative modes (Victorian Transport Policy Institute, 2018).

Numerous strategies can be used to reduce congestion for buses, both transit and school. Routing strategies can be both temporal (e.g., moving routes to less congested periods) and spatial (moving routes to less traveled roads). However, transit bus routes are designed with the passenger in mind, who tend to travel during peak times and along crowded corridors, the same as other travelers; school bus routes are dictated by school start times and while transportation is one factor school districts consider when planning start times, it is not the only one.

Other strategies can involve infrastructure changes. For example, buses can have signal priority at stoplights or special bus lanes to travel on. Along highways with adequate space, buses can be allowed to travel along the shoulder during peak times. These interventions may have additional construction and maintenance costs and could possibly increase congestion for other non-bus vehicles.

Cost of Intervention(s)

Understanding traffic congestion is important because it impacts the local and regional economy. Traffic congestion has increased significantly in the United States (Beaudoin, 2018) which prioritizes finding a solution. The total cost of congestion to the United States is estimated at $85 billion, or $763 per commuter, per year (United States Department of Transportation, 2019).

To combat this cost, a substantial share of transportation expenditures is spent on mass transit (Nelson, 2007). Beaudoin et al. estimate this amount is over $18 billion per year. On a related note, Nelson et al. agree that subsidizing transit can improve traffic flow to a degree which is proportional to the level of subsidy for the service. Duy et al. (2018) agree that the net congestion impact of buses is positive and recommend combining public transportation and

congestion pricing. This is important because congestion pricing can produce a welfare gain of $17.6 billion dollars annually (United States Department of Transportation, 2009).

School Transport Management has many methods to reduce congestion, but they vary in difficulty and cost. Some of the less costly methods to implement include marketing and encouragement programs for parents and students. Further, behavioral changes, like parking away from school, changing event timing, and organizing a walking school bus would be more challenging but still relatively low cost. In the short term, traffic calming techniques can be combined with additional bike parking and parking management. These are more costly but improving bike and pedestrian facilities results in an 18% increase in walking and biking (McDonald, 2014). The National Center for Education Statistics (2021) calculates the average expenditure per student transported to be nearly $1,000. This makes up 7.5% of total U.S. public school expenses and 12% in rural areas (VTPI, 2018). In the long-term, effective School Transport Management includes redesigning communities to be meant for families. This is accomplished by locating schools closer to neighborhoods to reduce travel distance. Reducing travel distances requires altering minimum acreage requirements, building codes, and design standards to allow a school in a residential area (Beaumont, 2000).

In conclusion, congestion is increasing and must be addressed. Adding frequent and affordable public transportation could be an effective method to reduce congestion on roadways, but this method should be considered along with congestion pricing. More research should be done to determine the impact, if any, of bus services alone in reducing congestion. Further, school travel also results in congestion. Adding school bus services is one method to reduce congestion. Another method is to use School Transport Management. While there are many possible interventions to reduce congestion, each option varies in cost and difficulty.

Methodology

The research team consisted of a group at North Carolina State University (NCSU) and a group at the University of Florida (UF). Both groups worked closely together throughout the project, but because the NCSU researchers were already familiar with the data and spatial analysis methods, the team opted for the NCSU group to take the lead in developing the procedures for data cleaning and analysis based on the North Carolina site. Meanwhile, the UF group would be primarily responsible for applying the developed methodology to the Florida site. In this section, both study sites are described, but the methodology and results primarily focus on North Carolina.

Site Selection

The goal was to choose one community in Florida and one in North Carolina, that varied some in basic characteristics (e.g., size, urban/rural nature, structure of municipalities), but shared the following criteria:

1. The local public transportation uses a GTFS (General Transit Feed Specification) feed for fixed route public transportation,
2. The local school district utilizes Edulog routing software,
3. The local school district is willing and able to share school bus routes, and
4. Roadway congestion is moderate to severe in at least some locations.

Most medium to large public transportation providers already have GTFS feeds. All school districts in North Carolina and nine school districts in Florida utilize Edulog. In addition, the school and transit agencies had to be willing to share basic financial information (e.g.,

operating and capital expenses, operating miles and hours, and vehicle replacement standards) to determine cost to the agency for each unit of delay.

Durham County, North Carolina

Durham County, North Carolina is one of the vertices of the Research Triangle, along with Raleigh and Chapel Hill. It is undergoing rapid growth, its population increasing from 233,000 to 301,000 from 2000 to the present day (Durham Open Data, 2021). The county is geographically dominated by the City of Durham; its only other incorporated areas are small extensions of Raleigh, Chapel Hill, and Morrisville from neighboring counties, with the rest of the area being unincorporated county land. Downtown Durham provides a relatively dense center, while the northern portions of the county are predominantly rural.

Durham Public Schools

Durham Public Schools (DPS) serves more than 32,000 students in both the county and the city (Durham Public Schools, 2021). Pre-pandemic data from November, 2019 shows that between 18,000 to 25,000 students take school buses daily (Transportation Information Management System, 2021). Utilizing a multi-tier routing system, DPS has 214 buses making 1,041 trips to/from school totaling 23,000 miles daily. This adds up to over 4 million bus miles per year and 250,000 driver payroll hours.

GoTriangle and GoDurham

GoDurham, formerly the Durham Area Transit Authority, operates 24 bus routes across Durham, many of them running out of the downtown Durham Station. This station also connects

to the GoTriangle transit system to provide out-of-county routes, including express buses to downtown Raleigh and Chapel Hill. In 2019, GoDurham served 6,760,036 unlinked passenger trips and supplied 4,287,156 revenue miles (Federal Transit Administration, 2019).

Pinellas County, Florida

Pinellas County is one of the smallest counties in land area in Florida, located on the Gulf Coast on a peninsula just west of the city of Tampa. A population boom keeps Pinellas County increasing, with the population growing from 921,482 to 974,996 between 2000 and 2019 (United States Census Bureau (1), 2019). With nearly 3,347.5 people per square mile, Pinellas County has the highest population density of any county in Florida, exceeding the next most dense county in Florida by nearly twice as much density. Multiple municipalities exist adjacent to each other across the entire county, with St. Petersburg being the largest of these with a population of 265,351 (United States Census Bureau (2), 2019). Together they weave a continuous urban grid from south to north that makes Pinellas County a characteristically dense, urban area. The county's economy is influenced by its proximity to the city of Tampa and its location in the greater Tampa Bay metropolitan area.

Pinellas County Schools

The Pinellas County School District serves an enrolled student population of 99,798 as reported for the FY 19-20 (Florida Department of Education, 2021). About 27,342 (nearly 27%) of those students were transported on school buses to their corresponding schools. The school district counts 603 school buses, 443 of which run one of 403 routes every day. An estimated 6,000,000 miles are driven by 458 bus drivers annually according to the most recent report.

Pinellas Suncoast Transit Agency

Pinellas County's own transit agency, Pinellas Suncoast Transit Agency (PSTA) currently operates 210 vehicles on 40 bus routes, 2 of which are express transit routes between Pinellas County and Hillsborough County, where Tampa is located (Pinellas Suncoast Transit Agency, 2021). The agency reports 13,615,634 million unlinked passenger trips in 2019 and supplied 13,380,238 revenue miles (Federal Transit Administration, 2019).

Datasets

Three datasets were used to collect vital information on the study area:

1. Regional Integrated Transportation Information System (RITIS) –archival traffic flow information on the study area such as the estimated harmonic mean speed, historic average speed for any hour of the day and week, and the associated reference speed (free flow). This data originates from aggregated vehicle GPS devices or Location Based Service data that is collected by a third party and in the case of Florida and North Carolina funded by FDOT and NCDOT respectively. RITIS information is not available on every road segment and furthermore is only available when there are sufficient observations. School bus routes, in particular, may often travel along non-RITIS segments, particularly as they traverse residential neighborhoods.
2. General Transit Feed Specification (GTFS) –a public data format for routing public transit on Google Maps. GTFS has standardized how transit agencies present stops, routes, calendars, and fare structures across most of the United States.

3. Education Logistics, Inc (Edulog) – a school bus routing software package used by school transportation departments across the country. Members of the research team at ITRE support the implementation of Edulog across North Carolina and work closely with software operators in over 100 districts.

Dataset Merging

This section is intended to provide a relatively thorough, but general overview of the steps taken to modify each dataset for eventual merging and calculation of travel delay.

The three datasets consist of spatio-temporal data that must be merged together, a process conceptualized in Figure 14. The temporal data was converted into tabular hourly profiles for each spatial segment. Merging the spatial data required significant geo-processing since they were based on different spatial datasets and had different network segmentation.

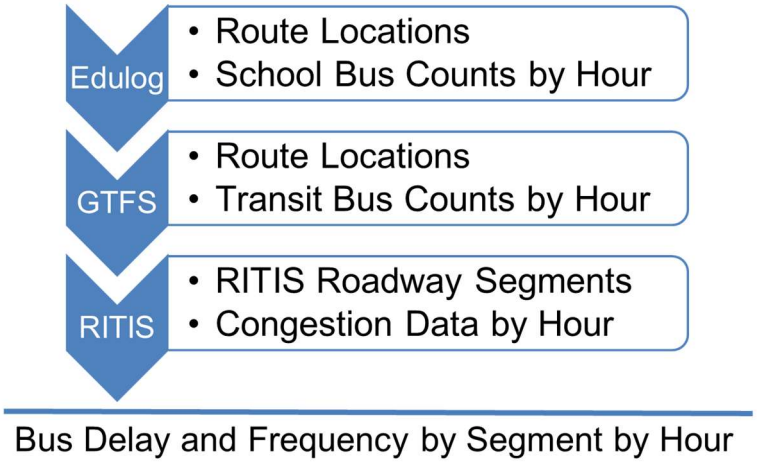


Figure 14. Methodology Conceptualization

RITIS

Raw RITIS probe data includes segment name, timestamp, speed, travel time and free flow speed. This data was downloaded for October 15, 2019 to November 14, 2019 to avoid major holidays and changes to school routing that may occur at the beginning of the school year. First, raw data were filtered to weekday observations on Tuesdays, Wednesdays and Thursdays, as these days of week are most representative of an average weekday. Next, average values for speed and travel time were calculated by hour of the day within the filtered dataset.

Overall delay can be calculated for the entire or partial RITIS segment using the analysis length divided by the difference between average speed and free flow speed. This value should be 0 or greater, as vehicles only experience delay when average speed is slower than free flow.

Edulog

The Edulog software is a bus route planning tool used to design daily school bus routes from start to finish. Bus route data includes planned stop sequences, projected times at bus stops and expected student assignments for each bus stop and route. The Edulog software algorithm provides optimal turn by turn directions between planned stop sequences based on local settings such as travel speeds, school bus turn restrictions, no-travel segments, etc.

To align the school bus routes temporally to the RITIS data, each route was assigned an hour based on the route start time. It was assumed that routes generally have maximum durations of 75 minutes. To assign the route to the hourly profile most closely associated with the congestion the route experiences, routes that begin between 00:00 and 00:14 of the hour were assigned to the hour, whereas routes that begin between 00:15 and 00:59 of the hour were assigned to the next hour.

Spatial bus route exports are not available from Edulog, but the software allows for tabular exports of stop coordinates and stop order as well as turn-by-turn route directions giving the intersections where turns occur. The turn-by-turn directions include intersections, but do not include municipalities. Combining the XY coordinates of known stop locations and geocoding intermediate intersections allowed the research team to "connect the dots" by a planned stop sequence using ArcPro Network Analyst. To determine the accuracy of these routes, a sample of routes were selected and compared against routes that were manually created using the turn-by-turn directions.

Some of the rules used to generate the bus routes in Edulog, such as allowing right-hand side stops only, could not be replicated within ArcPro's Network Analyst environment resulting in some discrepancies between the two methods. However, the discrepancies were minor and the amount of effort required to manually create all of the routes resulted in the research team agreeing to use the automated process. This allowed the research team to focus their efforts on the process of combining the three datasets together to create the final result.

Routes for Durham County, NC, were created using turn-by-turn directions obtained from the Edulog software. In automating the process of creating the routes between any two stop locations, a bus has many available paths of travel. However, Edulog provides a single path for the bus to follow. In order to more accurately match the automated routes to the Edulog routes, the turn-by-turn directions for each route were analyzed and XY Coordinates were generated for each intersection between known stop locations. The XY Coordinates for the intersections were then included with the XY Coordinates for the known stop locations, resulting in a more accurate representation of the bus routes that matched up well with the actual assigned routes.

However, the turn-by-turn approach could not be applied to the Pinellas County, Fl, dataset because the data does not include the municipality name. Durham, NC, has few municipalities, whereas Pinellas County, FL, has over 25 municipalities (Pinellas County, 2021). Without municipality names, geocoding intersections with common names such as 1st and Main caused false assignment to the wrong municipality which created unreliable routes. The manual effort required to clean up the false assignments meant that this method was not going to be easily replicable. Therefore, it was decided to use the network analyst approach using only known stop coordinates for the Pinellas data.

Once these data were cleaned, they were geo-located through ESRI's geoprocessing tools. For the intersections that corresponded to actual bus stops, the calculated coordinates were overwritten with the known X- & Y-coordinates. This process was repeated for several cities: Durham, Bahama, Rougemont, Raleigh, Chapel Hill, Hillsborough, and Morrisville. Although the majority of intersections fell within Durham, Bahama, and Rougemont, some bus stops are actually located in neighboring counties so it was necessary to add the additional cities to ensure these stops were not only located but located accurately.

After geo-locating the bus stops, the routes were created through the Network Analyst tools within ESRI's ArcPro software. The street reference data used was obtained from the North Carolina Department of Transportation GIS division and is named NCRouteArcs. A network dataset was created and built. The routes were created using the Run ID for the route name and the Run Direction Position for the sequence within each Run ID. After running the Network Analyst Route solver, 1,040 routes were created.

GTFS

GoDurham and GoTriangle are the two major fixed route public transit systems that operate within Durham County. Their General Transit Feed Specification (GTFS) data was used to help researchers understand the frequency of buses in Durham County as well as the spatial location of these frequencies.

Both GoDurham's and GoTriangle's GTFS data were collected from transitfeeds.com. The GTFS data used for GoDurham was published on October 25th, 2019 and for GoTriangle the GTFS data was published on October 21st, 2019. Using these two datasets, researchers were able to find a common date in which their system calendars aligned: Wednesday November 6th, 2019. This date is important as Wednesday represents a "normal operating day" that can be combined with the RITIS data.

The next step in processing the GTFS data is running it through an R Studio script that extracts the frequencies of each route. A script written by Santiago Toso (2021), was used as a basis to obtain the frequencies for this project.

One of the larger modifications made to Toso's R Studio script was rounding the stop times to capture the hour that has the majority of service based on the start time of the trip. After looking at the data, many of the routes had run times greater than 60 minutes. As with the school bus data, if the start time of the route was between 00:00 and 00:14, the trip was assigned to that hour and otherwise was assigned to the next hour.

Before exploring the frequency data with the spatial data, the shapes.txt file in the GTFS dataset needed to be modified as there are often numerous shapes tied to one route. This is due to many routes having different patterns throughout the calendar year. This modification process involves importing the following GTFS files into MS Access: shapes.txt, calendars.txt, and

trips.txt. Researchers used a query to find the desired service_ids and they were joined to trips.txt in a separate query. Then a query found the shape_ids active during the service_ids previously found. The final query consists of joining these active shape_ids back to the shape.txt file to only pull the active shape_ids for the study period. A table was exported with the reduced shape.txt data which replaced the original shapes.txt in the GTFS dataset. Once a frequency output was generated for the transit system and the shapes were limited to the ones for the study period, both the frequencies and the shapes were imported into GIS where the frequency export was joined to the GTFS route files using the route_id field.

Multiple attempts were made to use the Snap tool in GIS to have the GTFS routes align with the school bus routes. Due to the size of the datasets, the Snap tool could take upwards of several hours to complete. Additionally, the results were not satisfactory. Many of the GTFS nodes would miss various school bus route alignments, and therefore the future spatial joins to RITIS would not be able to calculate properly. Even through a considerable amount of manual effort to realign the Snap tool outputs, the spatial join to the RITIS data yielded inaccurate results.

Therefore, a final output for the GTFS route data was derived by using the Generate Shapes from GTFS tool and Network Analyst. The Generate Shapes from GTFS tool allows a user to create a GTFS shape based on a network dataset. This was important as it allowed researchers to obtain perfect alignment with the school bus routes by using the same network dataset. The Generate Shapes from GTFS tool was used for both GoDurham and GoTriangle. Running the Generate Shapes from GTFS tool creates multiple outputs: 1. A polyline feature class estimating the routes; 2. A point feature class representing the stops; 3. A trips.txt file matching the base trips.txt file but including the shape_id. The stops created from this tool were

connected using the same network dataset and process that was used to create the school bus routes. This ensured complete alignment of the transit routes with the school bus routes.

Figures 15 through 17 showcase the three datasets for Durham County, while Figure 18 overlays the three datasets atop one another; it should be noted that not all RITIS segments had accessible data for the time period in question. As can be seen, the majority of public transit routes travel along RITIS segments. This is less true for school bus routes, which, by necessity, pass through residential neighborhoods, that are less likely to be monitored by the RITIS network. These local streets might be expected to have less chronic congestion, although the system may miss congestion near the schools themselves.

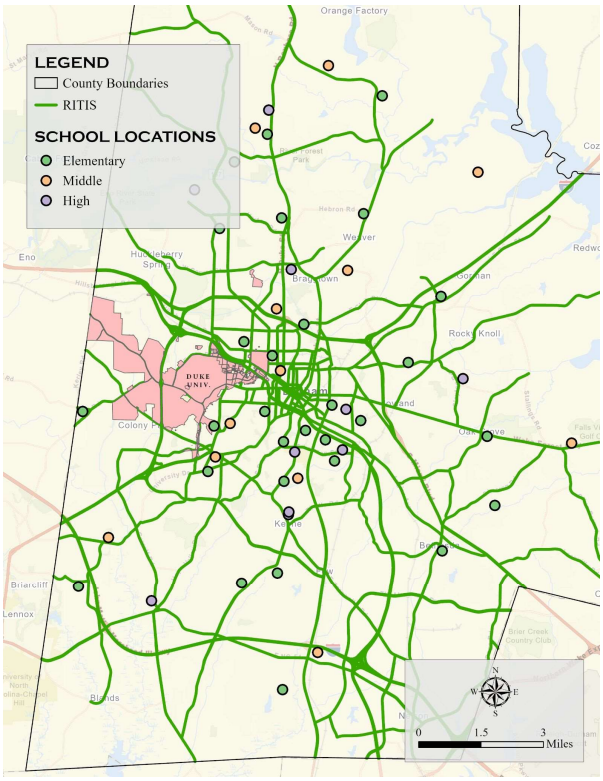


Figure 15. RITIS Segments in Durham County

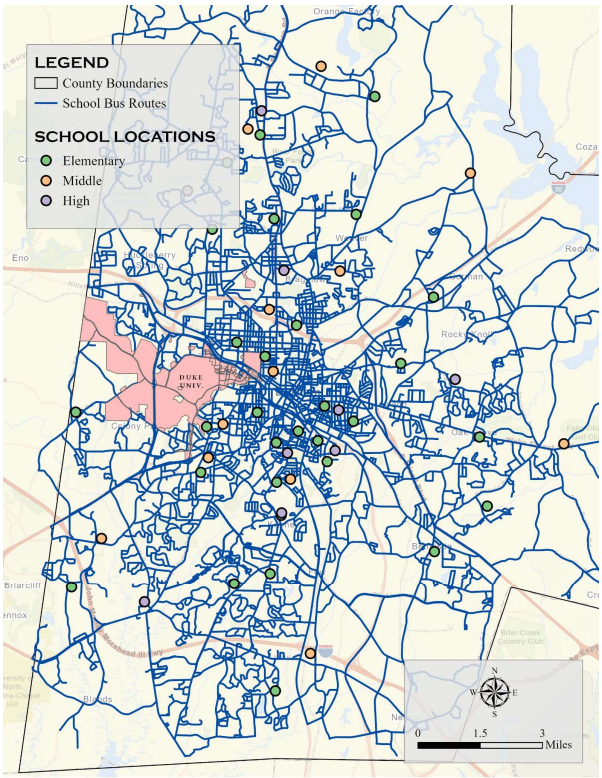


Figure 16: School Bus Routes in Durham County

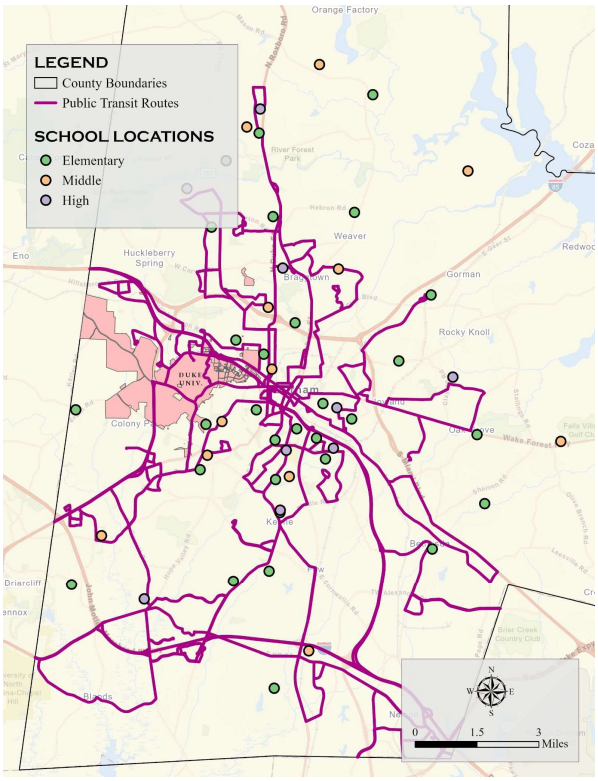


Figure 17. Transit Routes in Durham County

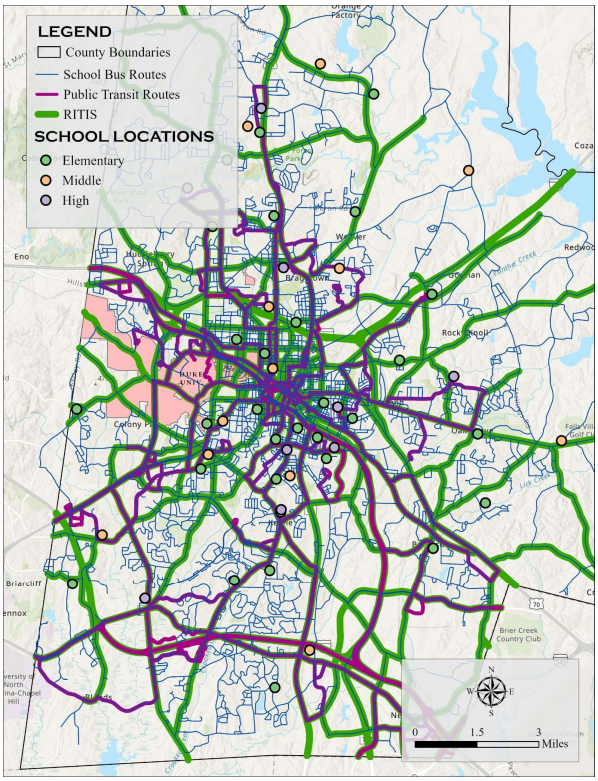


Figure 18: RITIS, School Bus Routes, and Transit Routes in Durham Count

Results

Using the above methodology, RITIS segments containing travel speed (and thereby travel delay when compared to free flow conditions) were aligned with school bus routes and transit routes. This allowed the research team to determine the travel delay experienced by each bus on each route segment at each hour of the day, including segment-hours with multiples of the same or different buses. These data for both study areas are presented in Table 13. The number of road miles refers to the physical miles, mapped out spatially. Route miles are much higher because a single bus may repeat the same route many times throughout the day and different routes often travel along the same road segments.

Table 13 summarizes the statistics derived from the analysis. Figures 18 – 21 show the minutes of delay by hour of the day for school buses and transit buses within Durham County (Figures 19 and 20) and Pinellas County (Figures 21 and 22). For both study areas there a significant number of bus route segments that are not coincident with RITIS segments and a large percentage of RITIS segments did not contain any congestion data. For these reasons, these numbers represent a minimum amount of delay during the days sampled.

Table 13: The network results for Durham County (left) and Pinellas County (right)

Durham, NC			
	RITIS	Edulog	GTFS
Road Miles	372	1,130	464
-Overlap with RITIS		178	220
Route Miles		27,661	16,336
-Overlap with RITIS		5,093	8,418
Minutes of Daily Vehicle Delay		3,392 (57 hours)	4,524 (75 hours)

Pinellas, FL			
	RITIS	Edulog	GTFS
Road Miles	957	2,131	967
-Overlap with RITIS		793	785
Route Miles		38,475	35,113
-Overlap with RITIS		20,046	28,730
Minutes of Daily Vehicle Delay		10,056 (167 hours)	7,205 (120 hours)

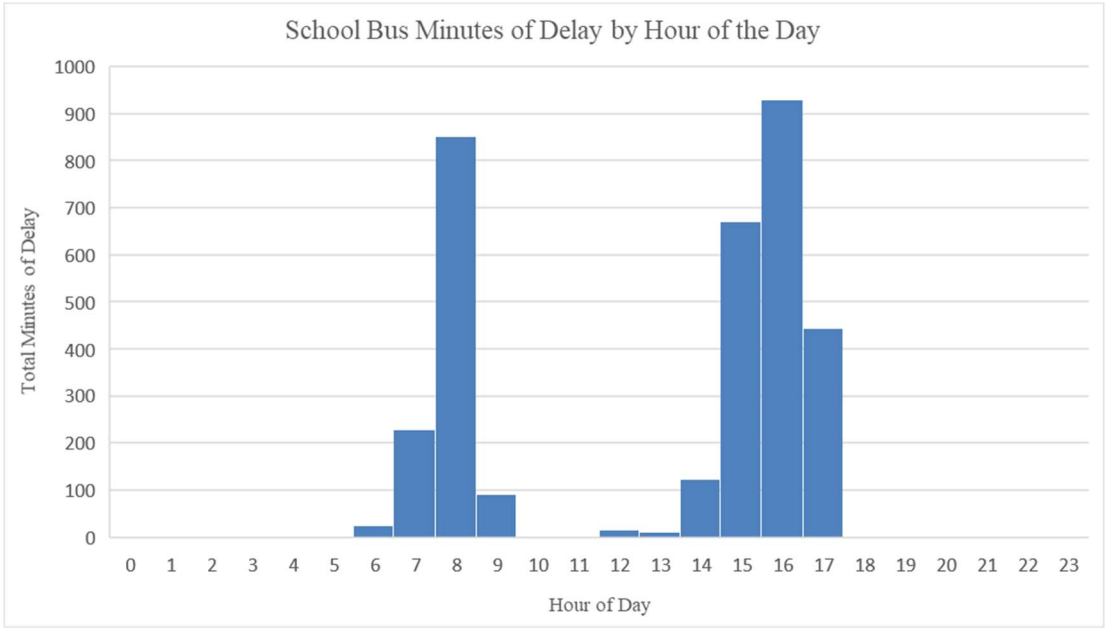


Figure 19. Durham School Bus Minutes of Delay by Hour of Day

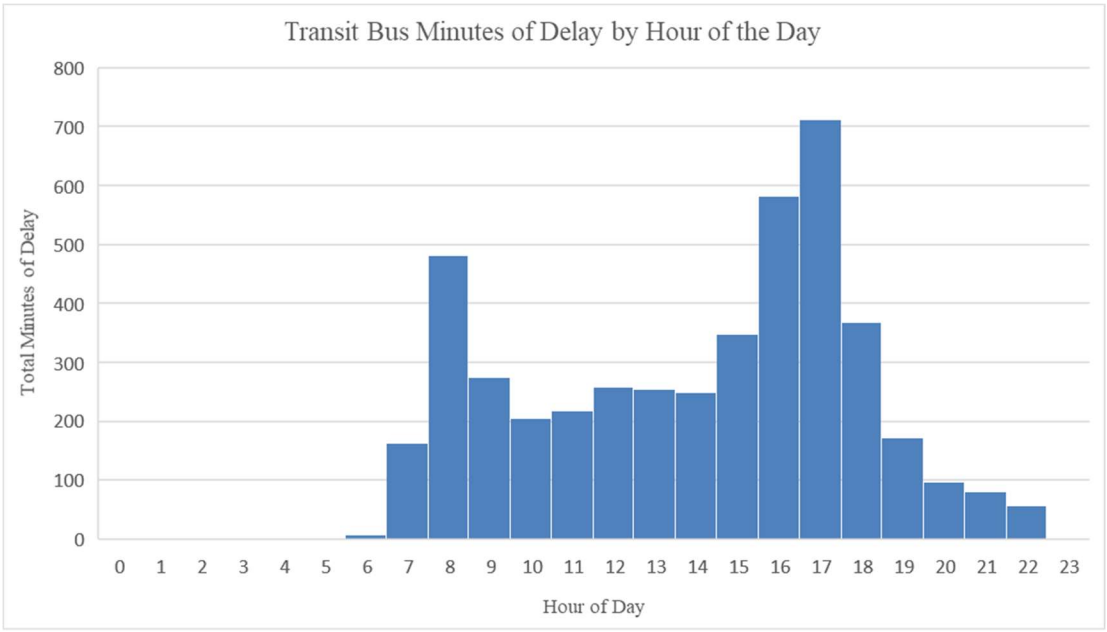


Figure 20. Durham Transit Bus Minutes of Delay by Hour of Day

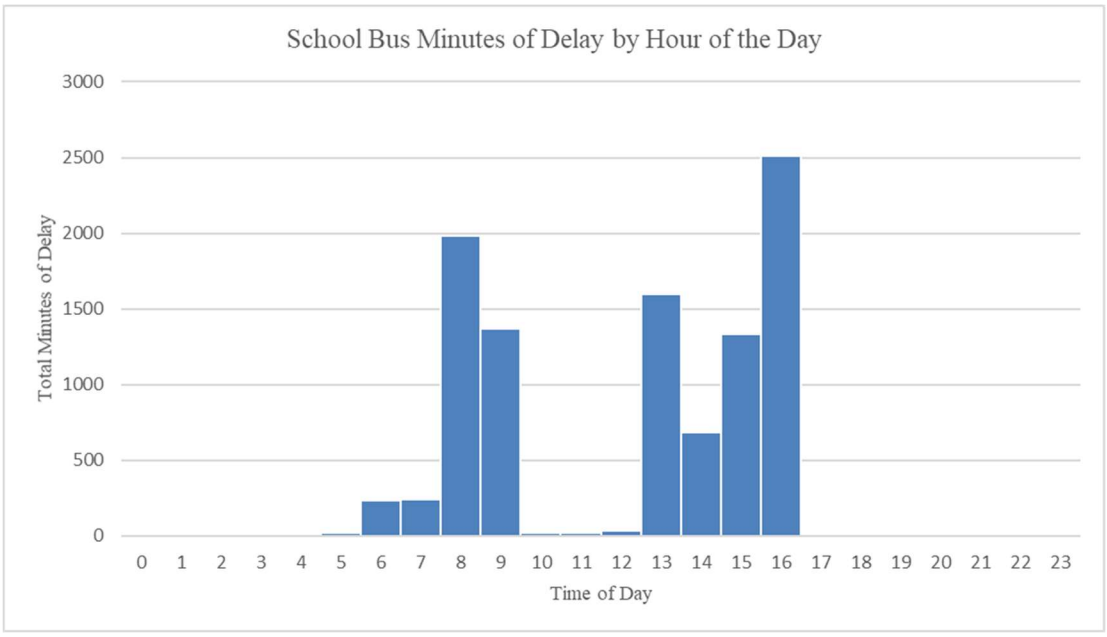


Figure 21. Pinellas School Bus Minutes of Delay by Hour of Day

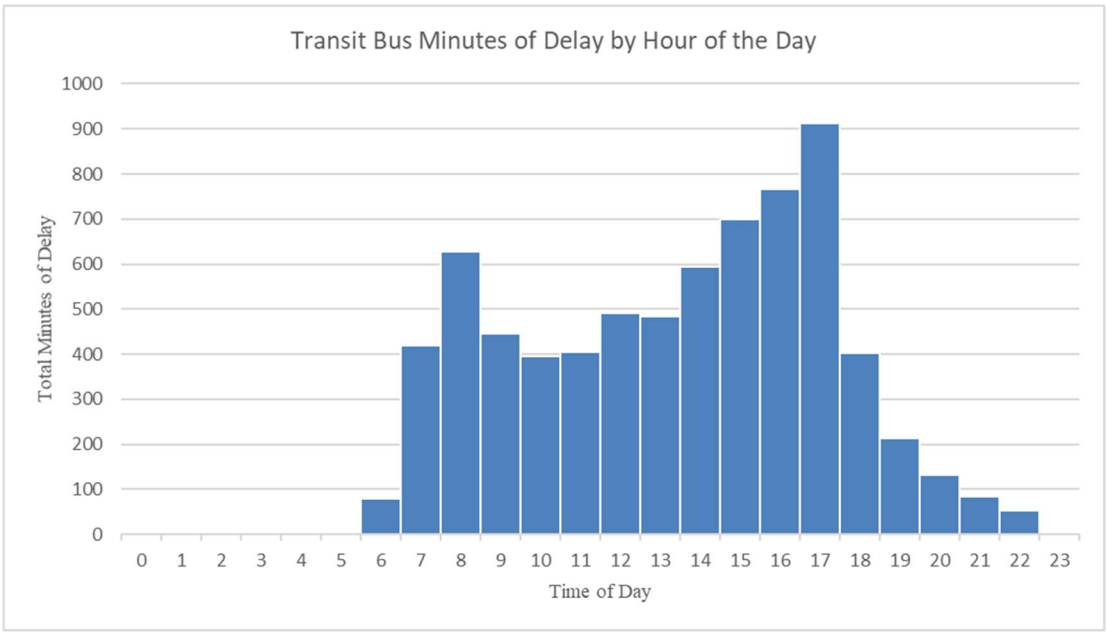


Figure 22. Pinellas Transit Bus Minutes of Delay by Hour of Day

An on-line mapping tool (Figure 23) was also developed to allow users to change time and location to better understand where and when congestion impacts school and transit buses. The map can be accessed via www.transitportal.org/cost_of_congestion.html. More about this tool can be found in the technology transfer report (Monast, 2022).

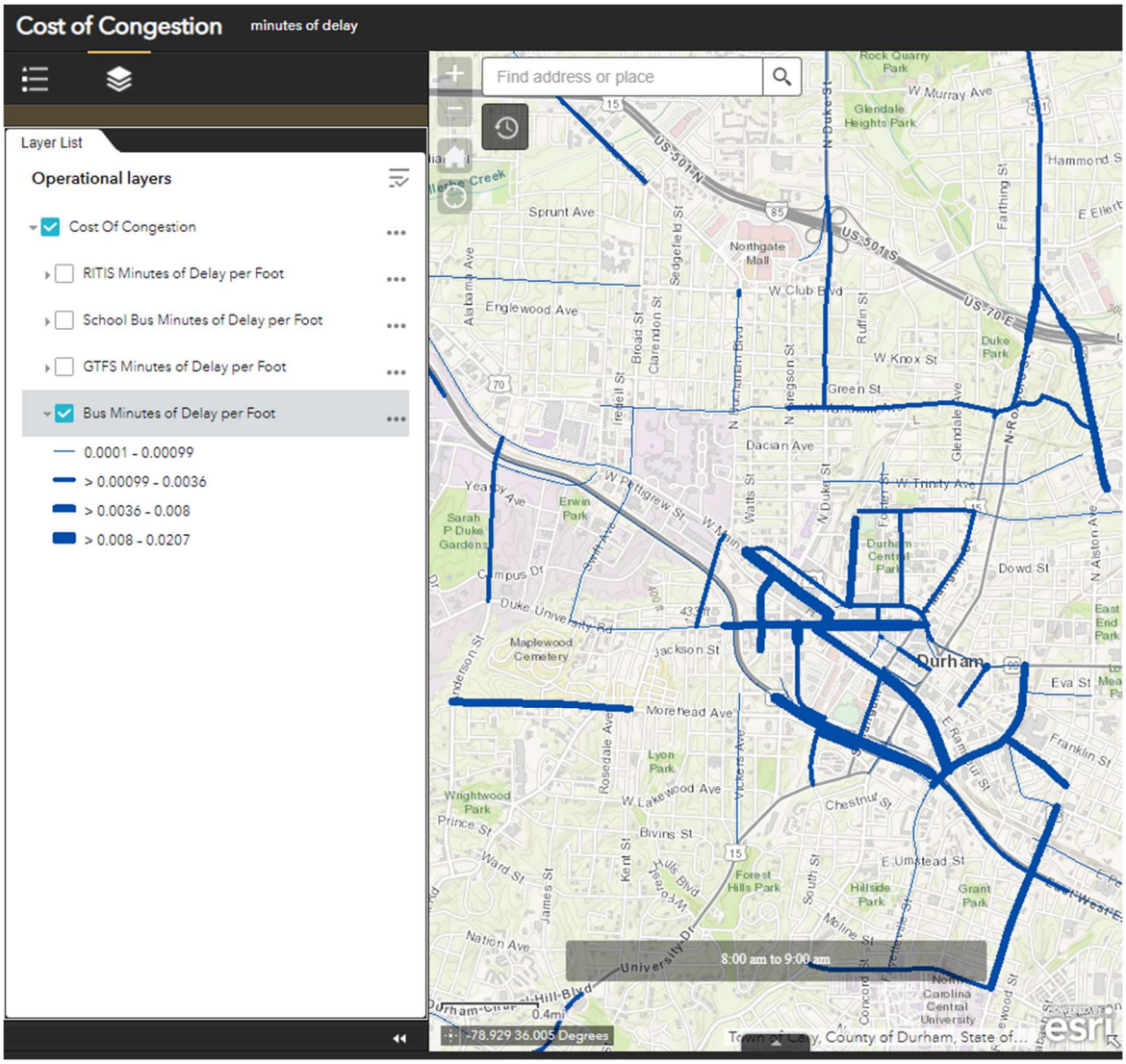


Figure 23. Cost of Congestion On-Line Mapping Tool

Analysis

Transit

According to these calculations, transit buses in Durham experience 75 hours of delay on RITIS segments on a typical Tuesday/Wednesday/Thursday day. Assuming that on average Mondays and Fridays are not likely to be less congested than midweek days and multiplying by 250 non-holiday weekdays per year, this would total to transit buses experiencing at least 18,750 hours of delay per year, or 781 days. Using GoDurham's estimate of $95.89 per hour cost for capital and operational expenses, this would mean an overall cost of $7,200 per day and $1.8 million per year.

Applying the operating cost of $95.89 to Pinellas County, the recurring daily delay of 120 hours results in a daily cost of $11,500 and a yearly cost of $2.875 million.

This figure does not include the cost in time lost for the passengers, since the research team did not have accurate rider count numbers per segment. However, using the US Department of Transportation's recommended hourly value of time savings of $17.90 (United States Department of Transportation, 2021) and assuming that GoDurham averages 10 people on the bus when the bus is experiencing delay, this results in a societal cost of $3,360,000 per year.

School Buses

The 1,041 vehicle trips undertaken each day by Durham school buses experience 113 hours of delay. Expanding this to the 185 school days in a year, this results in 20,900 hours, or 871 days. The researchers were unable to secure a cost per hour for operating and capital expenses from Durham Public Schools. However, using an estimated cost of $75 per hour, a

figure that was verified as reasonable by school transportation staff, results in a daily cost of congestion of $8,475 and $1.5 million per year. Applying the same cost to Pinellas County school buses results in a minimum cost of $12,525 per day over $2.3 million per year.

Discussion

The methodology developed for this research was able to produce temporal and spatial results showing where and when school and transit buses are impacted by recurring congestion and to convert the congestion into daily and annual capital and operating costs. By understanding exactly where and when congestion creates delay for bus modes and quantifying the extent and costs of these delays, planners and policy-makers can pursue mitigation strategies. Practitioners can use this research to prioritize locations where mobility solutions should be deployed to have the greatest impact on decreasing transit and school bus service provider costs and increasing levels of service. These strategies include re-alignment of routes or school bus entrances, informing land use planning policies, establishing bus lanes, implementing queue jumping, or developing other planning, operating or technological solutions. Transportation providers may also use the research to support changes in operational and capital budget requests.

Considerable effort has been devoted to identifying the most appropriate techniques to combine the three key datasets while also balancing the need for the methods to be replicable at other time periods and in other jurisdictions.

There are some limitations to address. First, the school routes are based on planned service, may not align with how the service was actually delivered, and do not include summer routes. Second, generating the school bus routes was time-consuming and their accuracy differed between the study sites due to data limitations. Third, although some agencies will have access to

more granular data, the RITIS congestion data available to the researchers is only available for major roadway segments and even then, is sometimes missing congestion data on some segment-hours, resulting in underestimations of the impact of congestion. Fourth, the transit network data have limitations such as not including ADA paratransit or other demand response modes, not accounting for schedule padding due to existing congestion, and is unable to account for the impact of congestion of fixed guideway services. Fifth, existing congestion mitigation treatments such as bus on shoulder interventions are unaccounted for, although these strategies are rare at these sites. Finally, the methodology does not address the possibility that the buses themselves may cause some of the congestion.

Unaddressed Issues/Future Research

This project was intended as a proof of concept that it is possible to calculate the costs of congestion on school districts and transit agencies using existing data sets. With that goal met, future research should be conducted to further refine the process, make it more accessible to even small agencies, and explore issues that were beyond the scope of this project. These questions include:

1. How much delay is on segments that do not match with RITIS data?
2. How is congestion already incorporated into routing and scheduling, such as using alternative routes and schedule padding?
3. How many riders experience the delay and what is their value of time?
4. How do we account for existing treatments to help the buses avoid congestion (e.g. bus on shoulder or dedicated bus lanes)?

5. How often do actual routes differ from scheduled routes (e.g., afternoon school routes)?
6. How can we include other times (e.g., summer school routes and weekend transit congestion)?
7. How do we incorporate demand response transportation?

CHAPTER 5: DISCUSSION

The first paper shows rural public transportation systems have difficulty aligning their stated goals and values with performance metrics. The second paper details the ridership and financial impacts of extreme external shocks to public transportation in the form of state policy decisions and the backdrop of a global pandemic. The third paper locates and estimates the cost of recurring congestion delay experienced by school and public transportation vehicles, another exogenous impact, albeit a much slower one. In many communities, recurring congestion builds slowly but has considerable long-term impacts on ridership and performance. After researching the issue of performance measurement in public transportation from multiple angles, the outstanding questions are should public transportation performance be measured and if so, how?

Not all trips have the same value to a person or to society. Transportation to cancer treatment, healthy food, employment, or education for persons without any other options represent essential mobility, which the nation acknowledged was a core need during the height of COVID-19 pandemic. In contrast, public transportation services related to reducing vehicle miles traveled and congestion reduction likely have much less value to the rider and society in general, as these riders often have other options. In addition, counting trips, which are boardings, unfairly benefits short distance modes while penalizing long distance modes. Therefore, trips alone cannot be the measure of performance.

Alas, most performance measures use trip counts as a dominant indicator of high-performance because they are easy to measure, as are miles and hours. Often, trips are combined with other output measures such as miles or hours to create trips per mile/hour, typical

measurements of efficiency. Many believe it is necessary to factor resource utilization into the trip performance measure to ensure efficient use of public resources. However, employing such factors rewards reducing transit service availability to peak hours only. In my hometown of Durham, NC, the buses run past midnight which doesn't help maximize efficiency but does enhance community mobility.

Because of the substantial differences in service area, demographics, resources, missions, and exogenous factors such as state policy changes and recurring congestion, comparing performance between public transportation systems is not a worthwhile endeavor. Indeed, performance measurement comparisons are more likely to be counter-productive because comparative metrics will not align with the mission and capabilities of the transit systems being compared. Instead, each transit system needs to draw upon community participation to develop its own definition of success and strongly resist external comparisons based on metrics not included in their plan.

After careful and thorough research and during the course of my career in the industry, the conclusion I have reached is transit systems must tell their story to the public and decision-makers but they should not use traditional performance metrics. Instead of allowing external actors with inappropriate performance metrics to define local success, each provider should develop core guiding principles and attempt to identify metrics that align with these principles. Likely, there will be multiple metrics and they will conflict with each other, meaning that maximizing any single metric should be avoided. Public sector industries best serve the interest of the public by setting goals instead of maximizing metrics.

But which metrics to use? If the easiest metric of trips is insufficient, metrics of efficiency can be perverse incentives, and outcome measures are difficult and may not even be

desirable to collect, we are left with opportunity measures. Opportunity measures are not output measures like miles and hours, but instead match demographics with access. For instance, an opportunity measure could be the number of people or people in communities of concern with the ability to access a transit stop within ½ mile where transit headways are 15 minutes or less at peak periods. Or, it could calculate door to door travel time for transit compared to driving alone in an attempt to create more parity between the modes.

Importantly, this research finds zero justification to support the inclusion of performance metrics in funding allocations because 1) public transportation cannot adequately measure what is important and 2) exogenous factors such as state policy changes and recurring congestion have tremendous impacts on performance measures. Instead of using performance metrics to allocate funding at the federal and state levels, I support geographic and demographic based formulas for funding public transportation and project-based discretionary funding. Before performance metrics are added to or have their influence increased any funding formula, the industry should require the funding agency to hold a public goal-setting process to ensure that metrics align with stated goals.

By no means will this research be anywhere close to the end of the road when it comes to performance measurement in the public transportation industry. I believe it is important that the industry not lose focus on the mindset change that happened during COVID-19 where public transportation was widely recognized as essential for the economic health of individuals and communities. Without mobility, core members of our society cannot participate in the workforce. The industry, therefore, has a great opportunity to redefine itself, changing perceptions away from the negative stereotypes of the past and towards positive impressions based on mobility, freedom, and participation. This opportunity should not be squandered.

Future Research Needs

If the true purpose of public transportation is to offer mobility, freedom, and participation in society, public transportation research needs to focus on these elements. Practitioners and the research community should advance this cause by developing processes, techniques, and indices that focus on how much opportunity is provided and leveling the playing field with other modes by comparing costs and travel times. Future research should focus on defining who has access to high quality, high frequency transit as well as the ridership experience from door to door. As a whole, the industry needs to define what baseline mobility is required in our communities and push to attain the resources necessary to ensure every person has an opportunity to access essential destinations and the freedom to participate in society.

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