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**WHO USES 311?
PATTERNS IN
CITIZEN-REPORTED
TRANSPORTATION
MAINTENANCE REQUESTS**



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The Center for Transformative Infrastructure Preservation and Sustainability (CTIPS) is the US DOT Region 8 University Transportation Center (UTC) located at North Dakota State University. CTIPS will focus on “Preserving the Existing Transportation System,” along with consortia members Colorado State University, Fort Lewis College, South Dakota State University, United Tribes Technical College, University of Colorado Denver, University of Denver, University of North Dakota, University of Utah, University of Wyoming, and Utah State University.

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ABSTRACT

This report explores trends in transportation maintenance requests submitted through municipal 311 systems across six U.S. cities: Denver, San Francisco, Charlotte, Nashville, Boston, and Washington, D.C. The 311 system is a non-emergency citizen relationship management component used by many cities to allow residents to report real-time conditions and request city services. However, there is ongoing concern that 311 systems may reinforce disparities in the distribution of transportation maintenance. Prior studies have shown that areas with higher proportions of low-income or minority residents tend to generate fewer 311 complaints, raising questions about the ability of 311 systems to support effective service provision. Despite this concern, relatively little research has focused specifically on transportation-related complaints. This study posits that 311 reporting may be more frequent among low-income communities when requests involve essential services, such as transportation infrastructure maintenance, rather than complaint types that may be considered more discretionary or “nuisance” in nature. By examining demographic patterns in transportation-related 311 requests, this study finds that transportation maintenance reporting behavior exhibits different patterns of participation from aggregated 311 reporting. The results offer guidance for planners and engineers considering the use of 311 data in effective, data-informed transportation maintenance planning.

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LIST OF KEY TERMS

311	Non-Emergency Municipal Service Request System
ACS	American Community Survey
AIC	Akaike Information Criterion
GEOID	Geographic Identifier
R	R Statistical Software
TIGER	Topologically Integrated Geographic Encoding and Referencing
VIF	Variance Inflation Factor

EXECUTIVE SUMMARY

Municipal 311 systems have become an increasingly important component of public service delivery by providing residents with a mechanism to report non-emergency issues directly to local governments. While these systems offer municipalities a cost-effective means of identifying infrastructure needs, concerns remain regarding whether 311 requests accurately represent transportation maintenance needs across all communities. Previous research has identified disparities in 311 reporting behavior based on neighborhood demographic characteristics, yet relatively little work has examined reporting patterns across transportation-related service requests specifically.

This study investigates the relationship between neighborhood demographic characteristics and transportation-related 311 reporting behavior using data from six U.S. cities: Denver, Colorado; San Francisco, California; Charlotte, North Carolina; Nashville, Tennessee; Boston, Massachusetts; and Washington, D.C. Transportation-related 311 requests submitted between 2019 and 2023 were standardized and categorized into transportation request categories before being aggregated to the census block group level. These data were combined with demographic variables from the 2023 American Community Survey to evaluate how neighborhood characteristics influence the frequency and category of transportation-related 311 requests.

The analysis identified significant variation in reporting behavior among communities. Census block groups with higher educational attainment, greater transit use, and higher poverty rates generally produced more transportation-related 311 requests, while block groups with older populations, higher proportions of residents with disabilities, and, for many complaint categories, larger minority populations generated fewer requests. These findings suggest that transportation-related 311 reporting reflects not only infrastructure conditions but also differences in civic engagement and interaction with the transportation system. Consequently, municipalities should be cautious that lower reporting volumes are not interpreted as lower transportation maintenance needs.

The findings demonstrate that transportation-related 311 data provide valuable information for identifying infrastructure concerns but should be used alongside traditional asset management practices rather than as a standalone indicator of maintenance priorities. Municipalities relying solely on resident-generated reports may underrepresent the transportation needs of communities that face barriers to participating in 311 systems, potentially reinforcing existing inefficiencies in infrastructure maintenance. Integrating 311 data with proactive inspection programs and targeted public outreach can improve municipal service provision.

1. INTRODUCTION AND BACKGROUND

1.1 Project Motivation

In recent years, municipal 311 systems have emerged as a method of connecting citizens efficiently with government services (Allen et al., 2020). Municipal 311 systems allow residents to request the resolution of non-emergency issues, consolidating many streams of communication across city departments and easing the burden of submitting service requests. These requests include a variety of issues, including parking, code enforcement, garbage removal, potholes, public health inspections, encampments, property taxes, overgrown vegetation, barking dogs, snow removal, and many other concerns. The 311 systems bridge the gap between the reporting resident and the department that can address the problem, alleviating some strain on maintenance budgets by providing a real-time condition report of city assets (Bolte, 2019; C. E. Kontokosta & Hong, 2021). However, in cities like Denver, even budget-friendly solutions like 311 are facing funding cuts, prompting questions around the value of these systems and whether they truly deliver positive outcomes for residents as promised (Grigsby, 2025).

Municipal 311 systems may provide a solution for cash-strapped municipalities needing assistance in identifying locations for maintenance attention. Funding for maintenance represents a nagging issue for many municipalities, with asset management systems unable to keep up with capital expansion projects (Dowd et al., 2020). This maintenance backlog necessitates a novel approach that supplements traditional asset management by supplying data on infrastructure for which condition data are not typically captured. The 311 system presents a commendable solution for efficiently addressing maintenance concerns. However, it cannot always be relied upon for efficient outcomes, as not all neighborhoods present the same reporting behavior when it comes to citizen-government coproduction (Cook et al., 2024; Minkoff, 2016). Disadvantaged neighborhoods already have failing infrastructure but also produce fewer 311 requests than their advantaged counterparts (Clark et al., 2013; Holgersson & Karlsson, 2014). With 311 participation difficult to generate, particularly from disadvantaged neighborhoods, these systems may only provide an incomplete picture of municipal assets. This gap in reporting between neighborhoods is only exacerbated by faster 311 response times in wealthier areas, with issues often amplified by city council or other political avenues to achieve quicker resolution (Bolte, 2019). While the relationship between 311 complaints and some locations is well-documented, little is known about how these locations generate transportation-sector complaints.

The analysis looks into the nature and location of transportation-sector 311 complaints, exploring the relationship between 311 utilization and neighborhood demographic characteristics. Data from 311 systems are available through most cities' open data portals; data from Denver, Colorado; San Francisco, California; Charlotte, North Carolina; Nashville, Tennessee; Boston, Massachusetts; and Washington, D.C utilized in the paper. While past studies do not compare 311 requests across cities because of inconsistencies in data reporting, this paper addresses this issue by using a transportation-related subset of the data and standardizing shared fields across datasets (Nalchigar & Fox, 2019). The identified transportation-related 311 complaint categories for analysis include bike, transit, parking, sidewalks, traffic, signs and signals, street lighting, and micromobility. We ask: how does the distribution of transportation-related 311 requests differ across neighborhoods? Do these patterns inform effective transportation maintenance, or widen

existing gaps in providing municipal services between advantaged and disadvantaged communities? We anticipate a more even distribution of transportation-sector complaints compared with 311 complaints overall. The essential nature of transportation complaints may influence reporting behavior and generate participation among communities that have historically been left behind in maintenance regimes.

1.2 Research, Objectives, and Tasks

The primary objective of this study was to examine how neighborhood demographic characteristics influence transportation-related 311 reporting behavior and the implications of these patterns for effective transportation infrastructure maintenance. To achieve this objective, the research was organized around the following tasks:

1. Conduct literature review
2. Identify data sources and verify data quality in case cities
3. Assemble data into geo-spatial and database formats
4. Clean data to focus on transportation-sector grievances
5. Conduct cluster analysis to identify census block group typologies
6. Conduct autocorrelation and causal statistical analyses
7. Present results to public officials
8. Share findings broadly through publications and presentations

1.3 Report Overview

This report is structured as follows: Section 2 reviews the current literature covering 311 reporting behavior and transportation infrastructure maintenance. Section 3 describes the methodology utilized in this study, providing an overview of the data cleaning and categorization process and the modeling process used to analyze the data. Section 4 presents the results of the study, which are discussed and interpreted in Section 5. Section 6 details the policy implications of the study findings and presents potential next steps for further research.

2. LITERATURE REVIEW

A large body of research exists examining municipal 311 systems and transportation asset management. However, few cover the intersection between 311 complaints and transportation maintenance by using a transportation-specific subset of 311 datasets to assess its relationship with the transportation system. This review focuses on the existing literature covering municipal use of 311 systems, transportation infrastructure maintenance and asset management, and the broader implications of using 311 to fulfill public services.

2.1 Municipal Use of 311 Systems

Researchers have analyzed the use of 311 by municipalities across the United States, with conclusions showing optimism regarding an improved provision of public services through targeted use of 311 data (Allen et al., 2020). Municipal 311 systems are shown to capitalize on a sense of “custodianship” felt by their users, in which they report issues in the vicinity of their home as a means of maintaining their neighborhood (O’Brien, 2015). While municipalities often view 311 systems as a way to optimize the allocation of limited financial resources for public services, differing perspectives exist on whether 311 exacerbates the digital divide present in citizen-government relations (Bolte, 2019; Cavallo et al., 2016). Providing a phone number option for 311 complaints can help alleviate the burden of internet access, but an analysis of Boston’s 311 system demonstrates that despite poorer neighborhoods yielding fewer 311 reports overall, these same neighborhoods use Boston’s 311 smartphone app at a higher rate than their wealthier counterparts (Chen, 2010; Clark et al., 2013). The translation abilities of an internet-based 311 system may also help reduce the digital divide, with Denver’s online 311 system able to operate in 72 different languages (McRae, 2025). However, there is little consensus around the ability of 311 systems to garner widespread participation from citizens, with observed difficulties in fostering engagement in general, but especially with residents from diverse economic backgrounds (Clark et al., 2013; Holgersson & Karlsson, 2014).

While 311 systems may not yet stimulate broad participation from residents, these systems add value to municipalities by aiding in fulfilling public services (Bolte, 2019). By allowing citizens to identify issues such as potholes, abandoned vehicles, or graffiti, and provide the exact location, governments can respond to issues faster while using less of their already thin maintenance budgets (Bolte, 2019; Clark et al., 2013). Participation in 311 systems can streamline issues, giving municipalities an assessment of the real-time condition of their infrastructure (C. E. Kontokosta & Hong, 2021). The increased utilization of 311 systems has aided in equalizing response times for services among neighborhoods, with a study of 311 response times in 15 U.S. cities observing “no systematic differences in how the cities respond that would indicate a bias against minorities and poorer residents” (Clark et al., 2020). Prior to the implementation of 311, municipalities often addressed complaints first in more affluent neighborhoods, with low-income and minority neighborhoods receiving lower quality maintenance responses (Clark et al., 2020). While debate remains surrounding the successes of 311 participation, 311 systems appear to improve the quality and speed of public service provision.

2.2 Transportation Infrastructure Maintenance and Asset Management

The increased utilization of 311 systems provides an opportunity for municipal transportation maintenance and asset management, with 311 requests generating a real-time condition report of municipal assets (Bolte, 2019). Infrastructure maintenance represents a significant concern for many municipalities, with continued infrastructure expansions only adding to the backlog of assets that require attention (Arif et al., 2016; Bai et al., 2021). With money less readily available for infrastructure maintenance compared with capital projects, local governments are often not equipped to handle the maintenance of their immense number of assets (Cottrell et al., 2009). Between sizeable backlogs and funding shortages, asset management programs continue to struggle as infrastructure deteriorates into a worse state of repair (Dowd et al., 2020; Halfawy, 2008).

With the limited dollars and employees available to complete transportation maintenance projects, municipalities often prioritize bridges and roads for maintenance over other types of infrastructure (Cooksey et al., 2011). Typically, engineering staff will determine maintenance schedules based on metrics like average daily traffic (ADT) and pavement condition, which does not always allow for prioritization of serious maintenance concerns related to sidewalks, street lights, bike lanes, signs, and signals (Arif et al., 2016). This standard practice can leave behind the transportation needs of low-income, minority community residents, who tend to drive less and rely more upon transit and alternative modes of transportation, according to the 2017 National Household Travel Survey (NHTS) (Wang & Renne, 2023). In providing transportation maintenance, 311 systems can begin to close this gap as resident reports of infrastructure needs fill in where traditional engineering metrics may not capture issues (Bolte, 2019). As a complement to municipal asset management systems, 311 systems show a strong upside with their ability to provide reports on a wide variety of real-time transportation needs.

2.3 Implementation and 311

While optimism continues around the potential for 311 systems to supplement asset management, reporting behavior has been found to have demographic variation, creating bias when municipalities use 311 data in decision making. Researchers find that low-income and minority neighborhoods have a lower propensity to report issues through 311, while high-income neighborhoods tend to over-report concerns (Cavallo et al., 2016; C. E. Kontokosta & Hong, 2021). These same low-income minority neighborhoods often have greater needs for infrastructure maintenance, but findings show that fewer public services are demanded in these locations (Cook et al., 2024). Relative rates of home ownership are hypothesized to influence this disparity, as residents may feel a greater sense of custodianship over their neighborhood when they own their home, as opposed to renting (O'Brien, 2016b). These differences can also affect response times for report resolution, with higher income areas seeing faster responses in a study conducted on 311 requests in New York City (Bolte, 2019).

In addition to the number of 311 requests, the nature of 311 requests also differs based on the demographic characteristics of a given neighborhood. Low-income minority neighborhoods often prioritize the most serious issues when reporting to 311, calling more frequently about infrastructure maintenance, street conditions, sanitation, and water (C. Kontokosta et al., 2017).

In contrast, higher income neighborhoods tend to report more about perceived safety issues or nuisances in their area, with the nature of their requests more related to code enforcement, garbage, parking, and other nuisance issues (Bolte, 2019; Stowers, 2022). However, a higher tendency for low-income minority neighborhoods to report about infrastructure issues does not guarantee that no gap exists in transportation-related 311 requests. These locations are more likely to have infrastructure in poor condition or lacking essential infrastructure, such as sidewalks, to begin with (Bolte, 2019). With expectations for infrastructure also affecting reporting behavior, underserved communities may also not perceive poor infrastructure condition as a reportable behavior to begin with (C. E. Kontokosta & Hong, 2021; Poirier, 2021). With the utilization of 311 systems becoming more widespread, these issues require further investigation to determine the specific impacts of a reliance on 311 for transportation infrastructure maintenance.

Much of the research on 311 systems centers on raw counts of requests, potentially obscuring trends specific to the transportation field. Exploring the specific nature of 311 requests uncovers additional insights into what might influence the reporting behavior of certain neighborhoods. Additionally, the dominant 311 literature typically covers one city per study, limiting the generalizability of findings to 311 as a whole (Minkoff, 2016; O'Brien, 2015). Further gaps remain in the understanding of neighborhood-level reporting behavior, with many studies normalizing reporting numbers by population. With more densely populated neighborhoods having less infrastructure per capita, transportation requests must be examined at the community level as opposed to the individual level. We expect differences in reporting behavior for transportation-specific 311 requests compared with 311 requests in general, which will be explored throughout this study.

3. METHODOLOGY

3.1 Data Summary

This study utilizes data from five years—spanning from January 2019 to December 2023—from six different cities: Denver, Colorado; San Francisco, California; Charlotte, North Carolina; Nashville, Tennessee; Boston, Massachusetts; and Washington, D.C. These cities were chosen because of their publicly accessible 311 service request data and their representation of variation in urban form, population density, and mode share—all factors that may contribute to infrastructure challenges and 311 reporting. While each sample city falls in a similar population bracket, this selection enhances the generalizability of results to different urban contexts. The six 311 datasets were retrieved from each city’s online open data catalog. Each city collects its 311 data slightly differently, but all the six datasets had common fields, including longitude, latitude, case created date, request type, and address. **Table 1** details a selection of summary attributes from each city’s dataset.

Table 1. Data Summary

City	Data Source	Years	Number of 311 Complaints	Number of Transportation-Related 311 Complaints	Most Prevalent Complaint Type
Denver	City and County of Denver Open Data Catalog	2019–2023	2,105,188	210,551	Parking
San Francisco	DataSF Open Data Portal	2019–2023	3,402,806	2,260,943	Street and Sidewalk Cleaning
Charlotte	City of Charlotte Open Data Portal	2019–2023	1,648,280	91,048	Recycling
Nashville	Metro Nashville Open Data Portal	2019–2023	1,248,900	214,929	Trash, Recycling, and Litter
Boston	Analyze Boston	2019–2023	1,373,853	698,461	Parking Enforcement
Washington, D.C.	Open Data DC	2019–2023	1,845,393	633,800	Waste Collection

This study also draws on American Community Survey (ACS) data from 2023 on the census block group level to assess the demographic characteristics of the block group within which the 311 complaints occurred. The variables used include median age, percent non-white, percent with post-high school education, percent of housing units that are renter occupied, percent of households with an income below the poverty threshold, percent with a disability, percent that use transit as their primary means of transportation to work, and percent that drive alone as their primary means of transportation to work. These variables serve as the explanatory variables in

the model, while the count of 311 complaints by census block group serves as the outcome variable. A summary of these variables is depicted in **Table 2**.

Table 2. Summary of Variables

	Variable Name	Definition	Source
Outcome Variable	Point Count	Number of transportation-related 311 complaints in a census block group in a year	311 open data
Explanatory Variables (Block Group)	Age	Median age	B01002 – Median age by sex (ACS 2023)
	Minority	Percent of individuals that identify as non-white or Hispanic	B02001 – Race (ACS 2023)
	Educational attainment	Percent of individuals obtaining some level of post-high school education	B15003 – Educational attainment for 25 and older (ACS 2023)
	Renter Occupied	Percent of housing units that are renter occupied	B25002 – Occupancy status (ACS 2023)
	Poverty	Percent of households with an annual income below the poverty line	B17021 – Poverty status in the past 12 months (2023)
	Disability	Percent of individuals identifying as having a disability	B18101 – Disability status (2023)
	Transit	Percent of workers over the age of 25 that use transit as their primary means of transportation to work	B08301 – Means of transportation to work (ACS 2023)
	Drive Alone	Percent of workers over the age of 25 that drive alone as their primary means of transportation to work	B08301 – Means of transportation to work (ACS 2023)

3.2 Data Cleaning

To facilitate an efficient analysis process, we took multiple steps to clean, standardize, and categorize the data. We began by standardizing field names and column order among the datasets from the six cities, setting up the individual datasets to eventually be combined with the same fields utilized for analysis. The common fields of longitude, latitude, case created date, request type, and address were included as the first columns of each dataset, as well as new fields that delineated a unique ID for each 311 complaint, the city of origin, and the year of the complaint.

To further maintain accuracy in the datasets, any 311 complaint that did not have a location, a date, or a category of complaint/description of complaint was removed.

Each 311 complaint was then categorized to determine whether it was a transportation complaint or not. As this study focuses on transportation-related 311 complaints, filtering out non-transportation related complaints was an essential step to prepare the datasets for analysis. The 311 datasets often contain a myriad of different complaint types, in addition to a variety of noisy data consisting of public complaints that were not tied to a specific city infrastructure issue. While each municipality categorizes its 311 data distinctly, common themes emerged that allowed for standardized sorting across datasets into transportation categories. We created a binary variable for transportation-related complaints, with transportation-related complaints receiving a 1 and non-transportation related complaints receiving a 0. Beyond that, complaints were sorted into two broad categories based on whether the complaint concerned a transportation asset or a transportation mode. Nine more specific categories were then developed to allow further insight into the variety of different transportation issues reported to 311, shown below in **Table 3**.

Table 3. 311 Transportation Categories and Complaint Frequency

Complaint Type	Category	Example	Complaint Count
Mode	Bike	Request for bike lane maintenance	3,989
Mode	Transit	Reporting missing trash can at bus stop	101,313
General	Parking	Reporting parking on sidewalk	1,278,501
Asset	Sidewalks	Request for sidewalk repair	110,804
Mode	Traffic	Request for traffic calming	27,725
Asset	Signs and Signals	Reporting broken signal	128,220
Asset	Street Lighting	Request for streetlight repair	74,506
Asset	Roads	Request for pothole repair	1,997,692
Mode	Micromobility	Scooter blocking sidewalk	4,264
Total			3,854,861

By compiling a comprehensive list of unique complaint types for each municipality, we were able to sort these into broader groups to allow modeling on the basis of complaint type. While San Francisco, Charlotte, Nashville, Boston, and Washington D.C. have preset categories for their 311 complaints that facilitate easy sorting, Denver’s 311 data do not contain any complaint category, instead using a text description of the complaint. This required the use of a set of unique keywords that captured and categorized each complaint into the corresponding transportation category.

Some transportation-related complaints are captured in the “total” category but were not sorted into any specific category because their low frequency did not meet the threshold for forming a unique analysis category (1,000). Among these were complaints about transportation-related issues concerning airports, freight trains, or Uber/Lyft, which are transportation-related but relatively infrequent in 311 datasets.

Following the categorization of the data, each 311 complaint was then assigned a specific census block group using TIGER line shapefiles in R based on its latitude and longitude. After being assigned a census block group by GEOID, each of the six datasets were imported into ArcGIS Pro. In ArcGIS Pro, each dataset was clipped to the boundaries of its respective city. This was necessary to ensure consistency in the data, as many cities receive 311 complaints from locations outside of their municipal boundaries that would instead fall into another jurisdiction. Once complaints outside of the cities were filtered out, the six datasets were imported back into R. At this point, complaints were aggregated to a summary on the census block group and year level, with each census block group having a count of transportation-related 311 complaints per year, as well as a count of complaints for each transportation category. This allowed us to control for the effects of time and location within the data, especially valuable considering the differences in ACS variables by city and the differences in reporting activity by year (with 2020 being an outlier in the available data).

To prepare the data for analysis, the datasets from each city were then combined according to the different transportation categories that are recorded in the 311 data for that city. As not all cities record their transportation-related 311 complaints the same way, it was necessary to create different datasets for each category. For example, the “sidewalks” dataset contains data from Denver, San Francisco, Nashville, Charlotte, and Washington D.C., but not Boston, as Boston does not record sidewalk complaints specifically as a unique transportation category. With 10 separate datasets, one for each transportation category and one for the complete dataset, each one was then joined with a table of ACS data containing the explanatory variables identified in **Table 2**. The final 10 datasets then contained a row for each census block group and year combination, with ACS variables included, that then had a count of 311 complaints based on the analysis category of the dataset. **Figure 1** represents the outlined methodology visually.

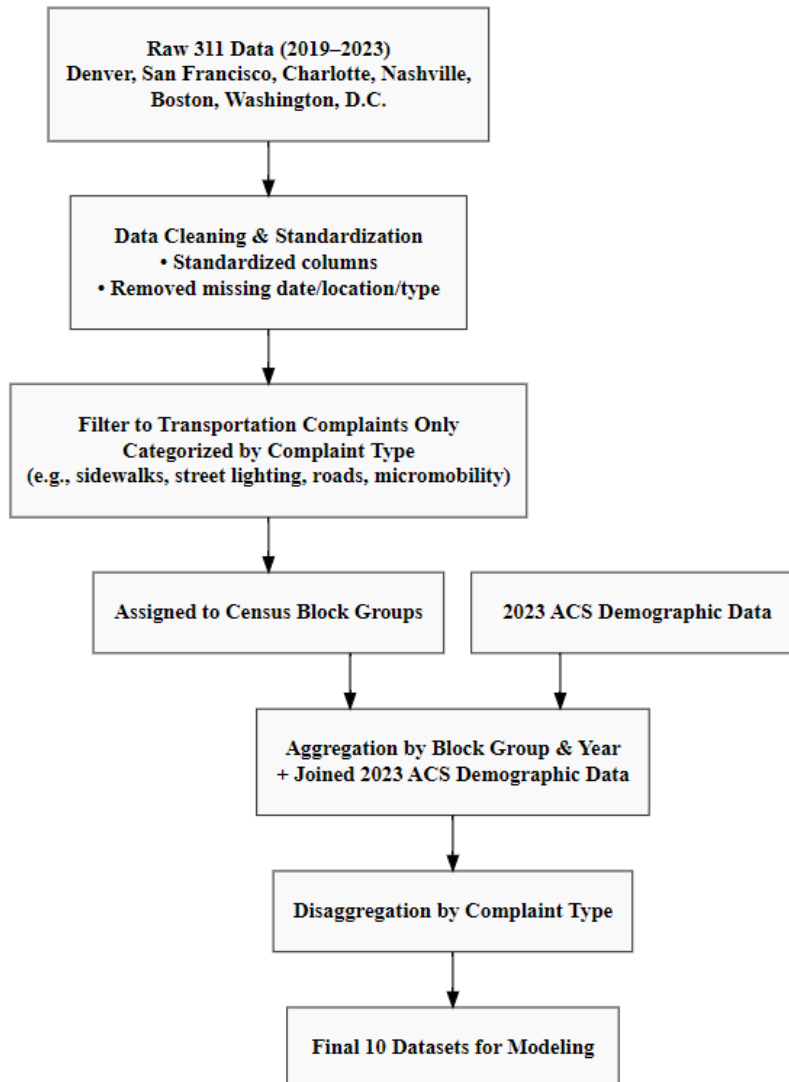


Figure 1: 311 Data Preparation Flow Chart

Table 4 shows the summary statistics for each dataset of transportation-related 311 complaints and the 2023 ACS variables across the set of census block groups used in this analysis.

Table 4. Summary Statistics

<i>Summary Statistics</i>	<i>Mean/Prop.</i>	<i>Std. Dev.</i>	<i>Median</i>	<i>Min.</i>	<i>Max.</i>
<i>Outcome Variables</i>					
<i>All Transportation-Related Complaints</i>	230.00	370.94	104.00	1.00	6,306.00
<i>Parking Complaints</i>	76.29	137.14	28.00	0	4,517.00
<i>Sidewalks</i>	8.01	14.95	4.00	0	509.00
<i>Signs and Signals</i>	11.71	16.65	7.00	0	359.00
<i>Street Lighting</i>	4.45	9.56	0	0	219.00
<i>Roads</i>	119.20	276.32	25.00	0	5,170.00
<i>Bike</i>	0.51	1.45	0	0	32.00
<i>Transit</i>	6.05	31.66	0	0	1,753.00
<i>Micromobility</i>	0.55	6.47	0	0	444.00
<i>Traffic</i>	2.07	6.12	1.00	0	582.00
<i>Explanatory Variables</i>					
<i>Age</i>	38.11	8.96	36.70	7.90	88.10
<i>Minority</i>	49.30%	28.36	47.06%	0	100
<i>Educational Attainment</i>	74.70%	20.23	79.59%	0	100
<i>Renter-Occupied</i>	51.84%	29.36	52.72%	0	100
<i>Poverty</i>	12.91%	13.54	8.49%	0	100
<i>Disability</i>	19.44%	13.80	16.87%	0	100
<i>Transit</i>	13.43%	14.36	9.13%	0	100
<i>Drive Alone</i>	45.21%	22.65	46.39%	0	100

3.3 Analysis and Modeling Approach

A count-based negative binomial model was selected for this analysis with a count of transportation-related 311 complaints by census block group by year as the outcome variable. A negative binomial model was preferred to a Poisson model because of the dispersed nature of the

data. While a Poisson model was considered, dispersion parameters for the 10 datasets (including zero values) ranged from 0.2 to 1.9, favoring a negative binomial for this approach as the variance exceeds the mean in all cases. The full dataset has a mean of 221.99 while having a variance of 134,579.44, confirming the need for a negative binomial model. The negative binomial model structure is useful when dealing with over-dispersed data, utilizing an added error term as indicated in the following equation (Milton & Mannering, 1998). In this case, λ_i is the 311 complaint frequency and X_i is the vector of the identified ACS variables.

$$\lambda_i = \exp(\beta X_i + \varepsilon_i)$$

Figure 2 and **Figure 3** show the distributions of transportation-related 311 complaints for two datasets: the full dataset and the parking dataset.

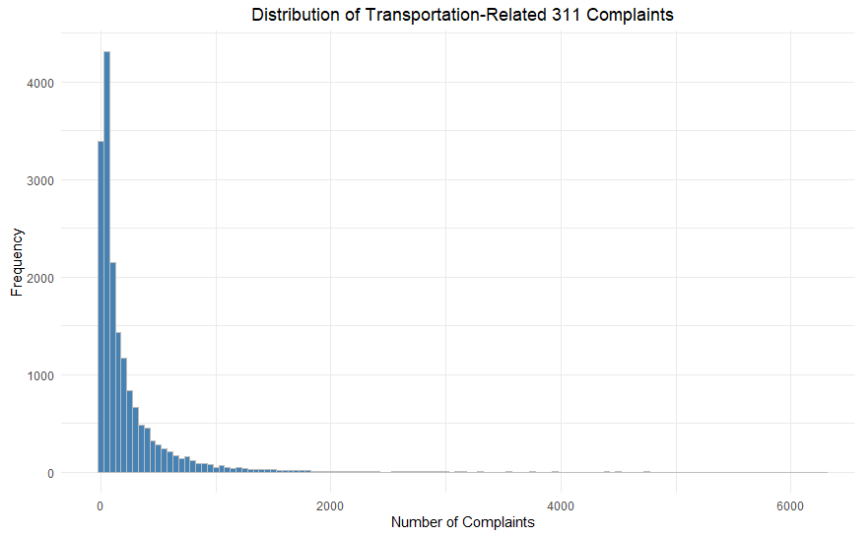


Figure 2. Distribution of Transportation-Related 311 Complaints

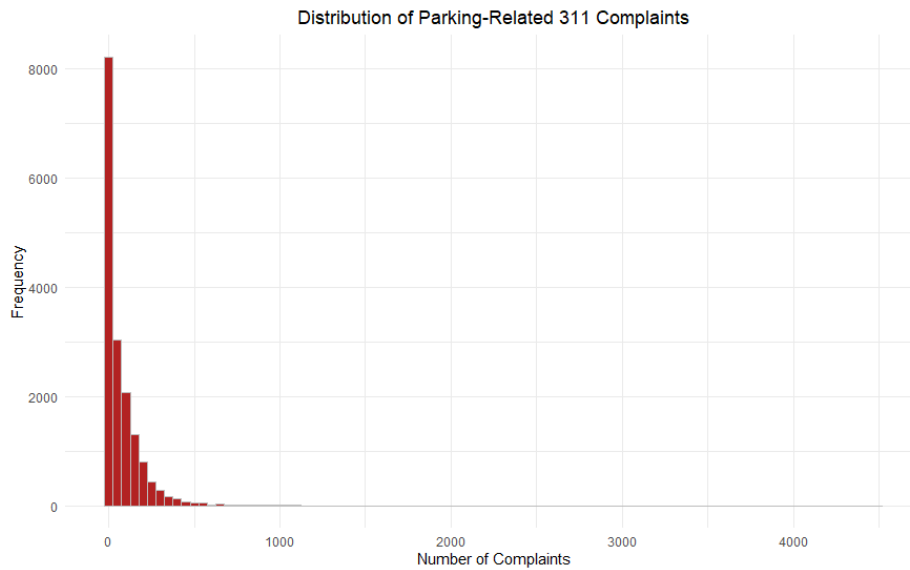


Figure 3. Distribution of Parking-Related 311 Complaints

Because of the high frequency of zeros in some of the datasets, a hurdle model was utilized for the five datasets that had over 20% of block group/year pairs with no 311 requests. The proportion of block group/year pairs with no 311 requests for each transportation category is shown in **Table 5**. A zero-inflated negative binomial was tested for the specified datasets, but either failed to converge or did not improve model fit in all cases, supporting the use of a hurdle model.

Table 5. Outcome Variable Zero Proportion by Transportation Category

Category	Percent Zero
All Complaints	0%
Bike	76%
Transit	64%
Parking	15%
Sidewalks	20%
Traffic	41%
Signs and Signals	12%
Street Lighting	51%
Roads	2%
Micromobility	89%

The transportation complaint categories of the five datasets were bike, transit, traffic, street lighting, and micromobility. This hurdle model included a binary component that modeled the probability of a complaint count being zero or not, as well as a zero-truncated negative binomial component that modeled the complaint count conditional on at least one complaint occurring in the block group for the given year. Variable selection for each component of the hurdle model was determined based on theoretical considerations of which variables affect the probability of reporting and which variables affect the complaint count conditional on reporting.

Random effects were integrated into all models to control for the effects of city and year on the counts of transportation-related 311 complaints. Different cities and different years experience baseline differences in complaint volumes, necessitating random effects in the model to account for these differences. For example, different cities may have different norms around reporting transportation issues or may have marketed the use of their 311 systems better than others. The selected cities also show significant differences among the selected ACS variables that can affect the model results but are accounted for by including city-level random effects. Temporal random effects are also necessary, with a portion of the data representing transportation complaints from 2020, which saw fewer complaints than other years and made up approximately 16% of the total complaint count. This variation is expected because of the COVID-19 pandemic and is accounted for using the year random effect.

The model specifications were tested using the variance inflation factor (VIF) and the Akaike information criterion (AIC). Calculating the VIF allowed assessment of any collinearity among variables. None of the variables scored over a 5 for VIF, indicating their inclusion in the model was valid. Comparison of the AIC of each model was then used to assess the goodness of fit of different model runs with different variable combinations. Through this process, income was removed as an explanatory variable in the model, as models with income included had a higher AIC than those with income removed. Additionally, the variables for income and poverty likely masked the effects of the other in the model when included together. This created further theoretical justification for the use of the poverty variable only in the model specifications.

4. RESULTS

This analysis identified variation by demographic indicators between census block groups in the number of transportation-related 311 complaints reported between 2019 and 2023. First, we discuss the trends observed in the largest two datasets (all complaints, parking) and three of the asset datasets (sidewalks, signs and signals, roads). These datasets had zeros for less than 20% of their values, allowing assessment with a standard negative binomial model with the inclusion of random effects for city and year. Second, we analyze lower-incidence complaint categories that had zeros for over 20% of their values. These datasets were mainly related to transportation modes (bike, transit, micromobility, and traffic) but also included the street lighting category. These datasets required use of a hurdle model specification because of their high percentage of zero values, using a binary model for the zero component and a negative binomial model for the conditional component, while including random effects for city and year in each component.

4.1 General and Asset Complaints

The dataset of all transportation-related 311 complaints from 2019–2023 contains nearly 4 million individual complaints, providing rich data for analysis. The full dataset reveals that transportation-related 311 reporting behavior varies with census block group demographic indicators. Increases in median age and disability presence in a block group were associated with fewer 311 requests about transportation issues, indicating that areas with a comparatively smaller mobile population often report less frequently about transportation issues. This was also true for areas with a larger minority population, with those census block groups associated with fewer transportation requests. However, a higher poverty rate for the census block group indicated an increase in 311 reporting about transportation. Additionally, areas with a higher proportion of renter-occupied housing also indicated greater 311 reporting, as did areas with higher rates of transit use for commuting and areas with higher educational attainment. This suggests that, despite these areas being income-disadvantaged, residents are connected to their community and aware of infrastructure issues, leading to more reporting of transportation-related 311 complaints.

The dataset for parking-related 311 requests exhibited similar characteristics to the complete dataset, with higher median age and higher incidence of disability associated with fewer complaints about parking. However, block groups with a higher proportion of minorities saw more complaints about parking, potentially indicating that these areas are suffering from a parking shortage, more illegal parking, or disproportionate parking enforcement. This was also true for areas with higher rates of transit use. Conversely, higher educational attainment was associated with fewer parking complaints, demonstrating either a lack of concern about parking or a lack of parking issues in highly educated areas, in contrast with transportation-related complaints overall.

Transportation asset-related complaints—including sidewalks, signs and signals, and roads—follow a similar trend overall to the complete dataset, but experience some differences. A greater median age and greater incidence of disabilities on the block group level were associated with a lower complaint frequency for transportation assets. While not significant in all of the models, this likely demonstrates a relationship between mobility and transportation complaints. A greater minority population was also associated with fewer complaints, showing a possible reporting

bias in which non-white individuals do not feel encouraged to report infrastructure issues in the same way as white individuals. Educational attainment and poverty rate were positively associated with asset-related complaints, showing that areas with higher educational attainment have a higher frequency of 311 reporting, likely due to an educational barrier to entry to using a system like 311. Areas with higher poverty levels having more asset-related complaints could indicate a lower quality of transportation assets and a lack of maintenance attention leading to a higher level of complaints.

Among datasets, the coefficient for renter occupation rate experienced far more variability, with a higher proportion of renters associated with more sign and signal and road complaints, while also associated with fewer sidewalk complaints. This variation could be explained by differences in infrastructure provision among neighborhoods: wealthier areas with more homeowners are likely to have more sidewalks than their counterparts with higher levels of renters. While signs, signals, and roads are present in all neighborhoods, in areas lacking a robust sidewalk network, fewer sidewalk-related requests would be expected. Finally, transit use was positively associated with all asset categories, indicating a similar trend to renter occupation that may be negated in many cases by visual exposure to infrastructure issues caused by spending more time traveling outside of a car.

Table 6. Complaint Frequency by Census Block Group by Year (General and Asset Complaints)

	<i>All Complaints</i>			<i>Sidewalks</i>			<i>Signs and Signals</i>			<i>Parking</i>			<i>Roads</i>		
	Coef.	Std. Error	Signif.	Coef.	Std. Error	Signif.	Coef.	Std. Error	Signif.	Coef.	Std. Error	Signif.	Coef.	Std. Error	Signif.
<i>Intercept</i>	5.016E+00	4.358E-01	***	1.211E+00	4.650E-01	**	1.941E+00	3.901E-01	***	4.188E+00	6.519E-01	***	3.746E+00	5.761E-01	***
<i>Age</i>	-6.846E-03	7.965E-03	***	-5.205E-04	1.348E-03		-1.100E-03	1.292E-03		-1.700E-02	1.200E-03	***	-3.577E-03	8.986E-04	***
<i>Minority</i>	-1.839E-03	3.294E-04	***	-3.258E-03	5.887E-04	***	-5.271E-03	5.210E-04	***	1.265E-03	4.968E-04	*	-8.273E-04	3.730E-04	*
<i>Educational Attainment</i>	1.381E-03	4.687E-04	**	8.870E-03	8.376E-04	***	3.533E-03	7.602E-04	***	-2.614E-03	7.037E-04	***	2.581E-04	5.277E-04	
<i>Renter-Occupied</i>	7.191E-04	2.702E-04	**	-3.046E-03	4.496E-04	***	3.911E-03	4.356E-04	***	1.800E-04	4.165E-04		6.615E-04	3.038E-03	*
<i>Poverty</i>	1.317E-03	5.648E-04	*	7.149E-03	1.045E-03	***	3.035E-03	8.878E-04	***	9.909E-04	8.606E-04		3.355E-03	6.615E-04	***
<i>Disability</i>	-3.741E-03	5.492E-04	***	-3.282E-03	9.827E-04	***	-4.023E-03	8.548E-04	***	-6.090E-03	8.394E-04	***	-2.863E-03	6.197E-04	***
<i>Transit</i>	4.270E-03	6.133E-04	***	2.780E-03	1.099E-03	*	3.471E-03	9.651E-04	***	2.339E-03	9.411E-04	*	3.868E-03	6.802E-04	***
	Variance	Std. Dev.		Variance	Std. Dev.		Variance	Std. Dev.		Variance	Std. Dev.		Variance	Std. Dev.	
<i>Year – Random Effects</i>	1.100E+00	1.049E-02		9.863E-01	9.931E-01		5.033E-01	7.094E-01		2.412E+00	1.553E+00		1.958E+00	1.399E+00	
<i>City – Random Effects</i>	1.231E-02	1.109E-01		2.949E-02	1.717E-01		7.595E-02	2.756E-01		7.132E-02	2.671E-01		2.126E-03	4.611E-02	
<i>Model Diagnostics</i>	Sum - Complaints	3,854,861		Sum - Complaints	110,804		Sum - Complaints	128,220		Sum - Complaints	1,278,501		Sum - Complaints	1,997,692	
	Obs.	16505		Obs.	13655		Obs.	10840		Obs.	16505		Obs.	16505	
	Disp. Parameter	1.87		Disp. Parameter	0.91		Disp. Parameter	1.19		Disp. Parameter	0.83		Disp. Parameter	1.54	
	AIC	191913.2		AIC	78607.2		AIC	70927.9		AIC	148681.5		AIC	156216.0	

Notes: bolded values are significant at 95%.

$p < 0.001 = ***$ $p < 0.01 = **$ $p < 0.05 = *$

4.2 Low-Incidence Complaints

Low-incidence complaints include issues concerning bikes, transit, traffic, street lighting, and micromobility. These complaints follow a similar overall trend to the larger dataset of transportation complaints, but specific variables experience variation among datasets. Increases in median age and disability predicted a greater probability of observing zero complaints, but both variables were insignificant in the zero component of most models. However, disability was significant and negative in all conditional components. A higher minority rate in a block group was associated with a greater probability of observing no complaints for bikes but was also associated with a greater probability of observing at least one complaint for traffic and micromobility. In the conditional component, the minority was associated with more traffic and transit complaints, but fewer bike, street lighting, and micromobility complaints.

Educational attainment and poverty were associated with a greater probability of observing at least one complaint for all categories in which they were significant. In the conditional component, poverty was also associated with more complaints for transit and street lighting. This once again suggests an educational barrier to entry to using 311 and a lack of maintenance provision in areas with higher concentrations of poverty.

Renter occupation rate experiences slight variability among low-incidence complaints. A higher rate of renters was associated with a greater probability of observing no complaints for bike and transit but associated with a greater probability of observing at least one complaint for traffic and street lighting. Higher rates of commuting by transit were associated with fewer complaints about street lighting; while higher rates of commuting via single-occupancy vehicle were associated with a greater probability of observing no transit complaints, as well as fewer transit complaints (given that at least one was observed).

Table 7. Complaint Frequency by Census Block Group by Year (Low-Incidence Complaints)

	Bike			Transit			Traffic			Street Lighting			Micromobility		
	Zero Component														
	Coef.	Std. Error	Signif.	Coef.	Std. Error	Signif.	Coef.	Std. Error	Signif.	Coef.	Std. Error	Signif.	Coef.	Std. Error	Signif.
Intercept	2.417E+00	8.073E-01	**	2.587E+00	1.442E+00		-5.740E-02	2.586E-01		2.678E+00	3.119E+00		6.665E+00	1.851E+00	***
Age	1.695E-02	4.040E-03	***	-1.243E-02	3.356E-03	***	3.755E-03	2.391E-03		-5.590E-04	3.499E-03		4.539E-03	6.026E-03	
Minority	6.908E-03	1.802E-03	***	-2.078E-03	1.449E-03		-5.477E-03	9.837E-04	***	1.262E-03	1.440E-03		-7.610E-03	2.619E-03	**
Educational attainment	-1.728E-02	2.609E-03	***	-3.942E-03	1.978E-03	*	-5.389E-03	1.357E-03	***	2.616E-03	2.024E-03		-2.160E-02	4.080E-03	***
Renter-Occupied	-6.823E-03	2.984E-03	***	-8.262E-03	1.067E-03	***	5.585E-03	7.684E-04	***	7.183E-03	1.106E-03	***	-6.617E-04	1.943E-03	
Poverty	-6.908E-03	2.709E-03	*	-3.554E-03	2.269E-03		-4.125E-03	1.607E-03	*	-5.439E-03	2.602E-03	*	-1.074E-02	3.940E-03	**
Disability	1.061E-02	2.916E-03	***	-4.251E-03	2.333E-03		-2.560E-03	1.635E-03		-4.259E-03	2.460E-03		7.675E-03	4.411E-03	
Transit ¹	-2.251E-03	1.223E-03		-	-		-	-		-	-		-4.408E-03	4.325E-03	
Drive Alone ²	-	-		4.329E-03	1.780E-03	*	-	-		-	-		-	-	
	Variance	Std. Dev.		Variance	Std. Dev.		Variance	Std. Dev.		Variance	Std. Dev.		Variance	Std. Dev.	
Year – Random Effects	1.524E+00	1.235E+00		1.1883E+01	3.4472E+00		1.247E-01	3.531E-01		4.5866E+01	6.7724E-02		3.0310E+00	1.7410E+00	
City – Random Effects	1.679E-01	4.098E-01		6.7740E-02	2.6030E-01		4.763E-02	2.182E-01		3.1500E-01	5.6120E-03		9.8430E+00	3.1370E+00	
	Conditional Component (Negative Binomial)														
	Coef.	Std. Error	Signif.	Coef.	Std. Error	Signif.	Coef.	Std. Error	Signif.	Coef.	Std. Error	Signif.	Coef.	Std. Error	Signif.
Intercept	-1.004335	0.541935		5.68E-01	8.21E-01		4.20E-01	2.19E-01		2.10E+00	2.54E-01	***	-1.79E+01	1.71E+03	
Minority	-5.49E-03	2.45E-03	*	4.15E-03	9.38E-04	***	2.04E-03	7.81E-04	**	-2.66E-03	5.52E-04	***	-1.04E-02	3.64E-03	**
Transit	5.17E-03	4.77E-03		-	-		-2.04E-03	1.82E-03		-6.71E-03	1.14E-03	***	-4.49E-03	6.03E-03	
Poverty	5.10E-03	3.95E-03		4.69E-03	1.76E-03	**	5.02E-04	1.50E-03		2.67E-03	1.01E-03	**	-2.42E-03	6.77E-03	
Disability	-2.00E-02	4.34E-03	***	-1.32E-02	1.53E-03	***	-5.41E-03	1.50E-03	***	-2.77E-03	1.02E-03	**	-1.52E-02	6.32E-03	*
Drive Alone ¹	-	-		-1.45E-02	1.23E-03	***	-	-		-	-		-	-	
	Variance	Std. Dev.		Variance	Std. Dev.		Variance	Std. Dev.		Variance	Std. Dev.		Variance	Std. Dev.	
Year – Random Effects	1.613E-01	4.016E-01		3.523E+00	1.877E+00		1.474E-01	3.840E-01		2.346E-01	4.844E-03		4.208E+00	1.741E+00	
City – Random Effects	1.541E-01	3.926E-01		4.002E-02	2.000E-01		7.652E-02	2.766E-01		2.586E-02	1.608E-03		2.276E+00	1.509E+00	
Model Diagnostics	Sum - Complaints	3,989		Sum - Complaints	101,313		Sum - Complaints	27,725		Sum - Complaints	74,506		Sum - Complaints	4,264	
	Obs.	7653		Obs.	16505		Obs.	13119		Obs.	16505		Obs.	7653	
	Disp. Parameter	0.14		Disp. Parameter	0.57		Disp. Parameter	0.44		Disp. Parameter	0.95		Disp. Parameter	5.03E-09	
	AIC	11713.3		AIC	47543.8		AIC	48441.8		AIC	58261.2		AIC	6449.9	

Notes: bolded values are significant at 95%.

p < 0.001 = *** p < 0.01 = ** p < 0.05

¹ For the traffic complaint model and the street lighting complaint model, percent of commuters taking transit was not considered a relevant factor in the zero component.

² For the transit complaint model, percent of commuters driving alone is substituted for percent of commuters taking transit.

5. DISCUSSION

These results provide insight into which communities report transportation issues to 311 more frequently, while also indicating what the nature of those 311 requests might be. By examining transportation-related 311 complaints through demographic variables, we can develop conclusions around 311 reporting behavior for transportation. These results highlight several relevant patterns.

5.1 311 Reporting by Socioeconomic Status

This analysis reveals that reporting behavior varies with the socioeconomic status of different communities. Census block groups with higher educational attainment tend to generate more complaints, with the exception of parking-related complaints. This trend aligns with existing literature on 311 reporting behavior, with communities with higher educational attainment more likely to have knowledge of the 311 system's existence while exhibiting greater levels of civic engagement to begin with (Clark et al., 2013). These neighborhoods may also have greater expectations for infrastructure provision and quality, leading to more frequent engagement with 311 systems on transportation issues.

Areas with higher poverty levels also appear to generate higher complaint levels across transportation categories. This differs from previous findings, with many 311 studies concluding that higher-income neighborhoods tend to report more frequently than their lower-income counterparts (C. Kontokosta et al., 2017). However, low-income areas have been found to generate a greater proportion of infrastructure maintenance requests as a function of their total number of 311 requests (Bolte, 2019). This reveals that when 311 data are filtered to include only transportation-related requests, the reporting behavior of high-poverty areas tends to reflect the worst infrastructure conditions and overall lack of infrastructure quality in these communities.

The level of reporting by census block groups based on minority population varies by transportation category, but a greater proportion of minorities is generally associated with lower reporting levels. This suggests systematic disparities in reporting behavior and infrastructure condition, which are supported by previous findings (Cook et al., 2024). Minority populations are more likely to reside in communities with worse infrastructure conditions, but this effect in the model is likely obscured somewhat by the poverty variable. The variation in complaint counts based on minority population likely reflects lower levels of civic engagement, expectations for infrastructure, and knowledge of the 311 systems in these communities.

The proportion of renter occupation in the analyzed census block groups creates varied results. While a higher proportion of renters is associated with more frequent reporting among all transportation complaints, it is associated with fewer complaints or a greater likelihood of zero complaints about sidewalks, traffic, and street lighting. The variability observed in complaints based on renter occupation levels indicates that two main factors are at play: areas with a higher level of renters while possessing worse infrastructure, and renters with less sense of ownership over their community infrastructure and therefore reporting less frequently. Higher rates of home ownership have been shown to predict higher rates of 311 complaints through a feeling of custodianship, but this effect may be masked by a greater need for transportation infrastructure maintenance in underserved communities, which typically have a higher proportion of renters (Cook et al., 2024; O'Brien, 2016a).

5.2 Disability and Age-Related Gaps

A relatively consistent finding across models is that higher disability rates and a greater median age are associated with fewer transportation-related 311 requests. This pattern is present across nearly all transportation categories and the conditional component of the hurdle models. These results demonstrate the presence of barriers to 311 engagements for the disabled and aging communities. This is likely due to the technological burden of modern 311 reporting that typically involves a mobile application or website, but also likely reflects a lack of personal mobility in these communities that leads to less interaction with their city's transportation system in general. As a result, these areas may end up with unmet infrastructure needs that are not accounted for in 311 requests. This also indicates accessibility barriers in 311 reporting for disabled and aging communities, which is consistent with the existing literature (Cavallo et al., 2016).

5.3 Travel Behavior

The models also indicate that a community's travel behavior influences reporting behavior. Areas with a higher share of transit commuters tend to produce a higher volume of 311 requests, while a higher share of commuters driving alone produces fewer complaints about transit-related transportation issues. This trend suggests that communities with more direct interactions with their transportation systems are more in tune with issues that might be present, particularly in relation to important pedestrian infrastructure such as sidewalks. Viewing the condition of the transportation system from the lens of a non-driver provides certain insights that drivers might miss, leading to more frequent reporting of transportation issues for areas with higher rates of transit use.

6. CONCLUSIONS AND RECOMMENDATIONS

This report explored the relationship between demographic indicators of census block groups and 311 reporting behavior on transportation issues. Using open-source municipal 311 data for Denver, San Francisco, Charlotte, Nashville, Boston, and Washington, D.C. from 2019 to 2023, we distilled these large datasets to represent only transportation-related requests. By pairing these data with 2023 ACS data and aggregating 311 requests to the census block group level, we analyzed the variation in transportation issue reporting among census block groups based on selected demographic variables. Using a combination of traditional and hurdle negative binomial models with random effects based on the city and year of the request, we gleaned valuable information on which communities are requesting transportation services via 311.

This analysis revealed significant differences in 311 reporting behavior across communities. As a result of disparities in 311 reporting behavior, the quantity of 311 requests in a community does not necessarily reflect the infrastructure needs of that community. Areas with greater educational attainment and transit mode share tend to report transportation issues more frequently, indicating a greater awareness of 311 systems and more on-site interactions with the transportation system. Varied trends in 311 requests based on minority populations and renter occupation suggest barriers to reporting as opposed to lesser infrastructure need, as these populations may not have knowledge of the 311 system or feel they can report issues that they see. These results align with previous studies that showcased 311 reporting patterns based on educational attainment, age, disability status, and minority population (Cavallo et al., 2016; Clark et al., 2013; Cook et al., 2024).

Other results added nuance to previous findings, with additional trends in 311 reporting revealed when requests were filtered to include only transportation issues. Greater levels of reporting in areas with higher poverty rates may serve as an indicator of greater infrastructure need and worse infrastructure condition, as disadvantaged neighborhoods often have poor transportation infrastructure (Bolte, 2019). This does not necessarily indicate that areas with higher poverty levels are reporting all transportation issues present in those neighborhoods, as there may still be unmet infrastructure needs not present in 311 data. Older communities and those with a higher disabilities rate experience that exact issue, as these neighborhoods are associated with lower levels of reporting. This demonstrates a clear unmet need that places limitations on the use of 311 data for the provision of transportation infrastructure maintenance. Relying solely on 311 data for maintenance could systematically underrepresent the needs of many populations, potentially reinforcing differences about which neighborhoods receive maintenance and transportation investments. Trends in reporting behavior should be accounted for in municipal use of 311 data, recognizing that reporting behavior may not reflect true infrastructure needs. However, knowledge of groups that may not be represented in the reporting of specific transportation issues provides cities with strategies to ensure true infrastructure needs are met despite varied reporting behavior.

Municipal governments can use these findings to better capitalize on the valuable data that 311 systems provide while ensuring they do not contribute to further inefficiencies in the provision of transportation services. A city's 311 data provide the real-time condition of many assets at little or no cost to the city, suggesting that targeted outreach around 311 to increase reporting will benefit cities and their dwindling maintenance budgets. However, 311 data can only truly serve

as a partial indicator of transportation issues, as shown through the significant variation in reporting behavior across communities that may not always correlate directly with infrastructure needs. Reactive maintenance systems can reinforce inefficiencies, showing that 311 data must be used alongside proactive maintenance strategies similar to those employed for monitoring pavement and bridges. Despite limitations, 311 data can form an important piece of the municipal transportation maintenance puzzle, lowering the barrier for citizens to call attention to transportation issues in their neighborhoods.

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