Minding the Gap: Identifying Job Accessibility Disparities in Charlotte's Transit System

Yasmeen Alzouby
University of North Carolina at Charlotte
Charlotte, North Carolina, USA
yalzouby@charlotte.edu

Kara Redanz
University of North Carolina at Charlotte
Charlotte, North Carolina, USA
kredanz@charlotte.edu

Bethany Schweitzer
University of North Carolina at Charlotte
Charlotte, North Carolina, USA
bschwei2@charlotte.edu

Alek Leonard
University of North Carolina at Charlotte
Charlotte, North Carolina, USA
aleona37@charlotte.edu

Sophia Hamid
University of North Carolina at Charlotte
Charlotte, North Carolina, USA
shamid2@charlotte.edu

Abstract

Transit systems are key to improving equitable access to employment, entertainment, and essential services in many cities in the United States. In this study, job accessibility via fixed-guideway transit is evaluated for the Charlotte metro area using GIS-based metrics. With many job centers across the city still out of reach by the light rail, this analysis explores which Census Block Groups (CBGs) have the largest share of jobs more than half a mile from transit stops. To understand where job access is limited by transit, we examine job concentrations, proximity to transit, and transit dependence using geospatial data and demographic variables. Underserved Census Block Groups are identified, employment types in low-access zones are assessed, and transit-dependent, low-income populations are highlighted. The areas in greatest need are then compared to current and planned infrastructure to visualize where improvements could have the most impact. Proposing more efficient transit extension options in neglected areas can boost economic mobility, connect more workers to jobs, and provide valuable insights for future transit growth.

CCS Concepts

• **Computing methodologies** → *Uncertainty quantification*; *Modeling methodologies*.

Keywords

Census Block Groups, Fixed-guideway transit system, Job decentralization, Spatial Mismatch Hypothesis, Transit-desert

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1 Introduction

Access to reliable public transportation is essential for economic opportunity [11]. In Charlotte, many job centers remain out of reach for people who rely on transit, especially those without access to a personal vehicle [6]. While the light rail connects key areas like Uptown and University City, much of the city depends on slower, less reliable bus routes. This can make commutes long, complex, or unpredictable—especially for people trying to access jobs in suburban or industrial areas not served by fixed-guideway transit.

As the city considers major transit investments like the Red and Silver Line expansions, it's critical to ensure that new infrastructure helps close, not widen, these gaps [10]. Our project explores where the current light rail system falls short and who is most affected. By analyzing Census Block Groups (CBGs), we examine where jobs are concentrated beyond walking distance of transit, what types of businesses exist in these areas, and whether lower-income or minority communities are more likely to face job inaccessibility due to poor transit coverage. Addressing this mismatch can improve job access and boost economic opportunities. When job accessibility is equitable for all socioeconomic groups, quality of life improves [4].

Ultimately, we ask: How can transit expansion better connect underserved job centers—and help level the playing field for residents who rely on public transportation to access economic opportunity? To explore this, our study investigates three key questions:

(1) Which CBGs have the highest concentration of jobs that are not easily accessible by transit?

(2) What types of businesses are common in areas with poor transit access, and how can they be better connected?

(3) Are lower-income or transit-dependent communities more affected by transit gaps?

Prior research has established strong connections between transit access and workforce outcomes, highlighting job access disparities across different demographic and geographic groups [3]. This research examines the connections between fixed-guideway transit accessibility, spatial mismatch, and transit deserts in Charlotte to help drive necessary change to current systems.

2 Background

Job accessibility, or the ease with which individuals can reach employment through transportation, is a key factor in shaping economic outcomes. When access improves, unemployment drops [2]. Research consistently shows that better job accessibility leads to lower unemployment and improved workforce outcomes, particularly when workers can reach jobs that match their experience and pay level [3]. For instance, increasing job access from the 25th to the 75th percentile is associated with a 4–7% decrease in unemployment [2]. Reliable public transit plays a central role in enabling that access—especially for individuals without a car. When transit systems fail to connect people to jobs, they limit options for transit-dependent workers. This imbalance can reinforce existing disparities in income, opportunity, and social mobility [8].

In many fast-growing, car-oriented cities, job growth has increasingly shifted to suburban and industrial areas not well-served by public transit [5]. This pattern has contributed to what researchers call spatial mismatch—a disconnect between where transit-dependent residents live and where jobs are located [7]. Even when transit service exists, poorly aligned routes and extended commute times can cut people off from employment opportunities[6]. This dynamic has given rise to transit deserts: areas with high need for public transit but limited practical access to job destinations [1].

However, not all forms of public transit are effective in mitigating these transit deserts. Buses often suffer delays due to traffic congestion, inconsistent scheduling, and longer, indirect routes. In Dallas, for example, transit deserts existed even in areas with bus networks, as commutes regularly exceeded 30 minutes [1]. In contrast, fixed-guideway systems—such as light rail—operate on dedicated tracks and offer greater reliability and permanence [10].

Charlotte's light rail system, LYNX, currently serves dense urban areas like Uptown and University City, but coverage remains limited, and many communities and job centers remain disconnected from this higher-performing infrastructure [10]. As Charlotte's population continues to grow rapidly, its development is sprawling outward, intensifying the disconnect between transit infrastructure and employment. For residents without access to a car, this means fewer realistic job options and longer, more complex commutes that may reduce workforce participation or economic mobility [9].

Charlotte's 2030 Transit Corridor System Plan (TCSP) serves as a comprehensive blueprint for expanding the city's transit infrastructure, focusing on five key corridors including the Blue Line (South and Northeast Corridors), Silver Line (Southeast and West Corridors), and the proposed Red Line (North Corridor) [10]. The plan emphasizes transit-oriented development (TOD) to promote compact, mixed-use urban growth along high-performance transit lines, aiming to enhance mobility and support economic development.

While the TCSP provides a strategic framework for transit expansion, our study offers further analysis to ensure that these investments equitably serve all communities. Specifically, our analysis will be conducted at the Census Block Group level, a small, standardized geographic unit that captures localized land use and employment variation. This granularity allows us to more precisely identify which communities and job centers fall beyond the ½-mile radius from light rail stops, and where expansion would close the most critical gaps. This spatially detailed, equity-focused approach complements the corridor-level planning of the TCSP. It helps ensure that new infrastructure directly improves access to economic opportunity for those who need it most.

3 Methodology

3.1 Dataset Description

The dataset used in this study comes from the EPA Smart Location Database (SLD). This national dataset includes data on transportation, employment, land use, and demographics for every Census Block Group (CBG) in the United States. The SLD integrates data from several sources, including the 2010 U.S. Census, LEHD Origin-Destination Employment Statistics (LODES), General Transit Feed Specification (GTFS), and the 2020 TravelTime API. It contains 117 variables, categorized into key areas: Demographics, Employment, Transit Access, Destination Accessibility, Street Design, Land Use, and Housing. Additionally, it features a calculated National Walkability Index for each CBG, offering critical insights into walkable transit access and employment distribution. This dataset was chosen for its comprehensive coverage and detailed spatial granularity, allowing for robust analysis of transit accessibility and employment distributions. We will focus on several key variables to assess the effectiveness of Charlotte's transit infrastructure in connecting workers to jobs.

To answer the first research question (*Which CBGs have the highest concentration of jobs that are not easily accessible by transit?*), we will be using:

- TotEmp: Total number of jobs in each CBG.
- D4B050: Proportion of jobs in each CBG within ½ mile of transit.

The ½-mile threshold—roughly a 10-minute walk—is a widely used benchmark for defining walkable transit access. By identifying CBGs with high total employment and low proximity to transit, we can pinpoint areas where many jobs remain effectively out of reach for transit-dependent workers.

To answer the second research question (*What types of businesses are common in areas with poor transit access, and how can they be better connected?*), we will be using the following employment classification variables:

- E8_Ret: Number of retail jobs.
- E8_Off: Number of office jobs.
- E8_Ind: Number of industrial jobs.
- E8_Svc: Number of service jobs.
- E8_Ent: Number of entertainment jobs.
- E8_Ed: Number of education jobs.
- E8_Hlth: Number of health care jobs.
- E8_Pub: Number of public administration jobs.

To answer the third research question (*Are lower-income or transit-dependent communities more affected by transit gaps?*), we will be using:

- Pct_AO0: Percentage of households without cars in each CBG. This identifies transit-dependent populations.
- E_PctLowWage: Percentage of lower-wage jobs in each CBG ($1,250 or less per month).

3.2 Data Exploration

The analysis begins with data preparation and exploration to assess transit disparities in Charlotte. The dataset was filtered to include only Charlotte-Mecklenburg County by selecting the relevant Federal Information Processing Standards (FIPS) codes, ensuring that all subsequent analyses were specific to Charlotte. An initial dataset review examined its structure and data types for consistency. Issues with FIPS codes appearing in scientific notation were resolved by combining the individual FIPS components into a new, string-formatted column to preserve their integrity. Additionally, one Census Block Group (CBG) with missing values for relevant variables was removed. From the cleaned dataset, variables related to job accessibility and transit access were prioritized. Non-essential columns were excluded to maintain focus on key factors influencing job accessibility through transit proximity.

To understand job accessibility in Charlotte, CBGs were analyzed based on the proportion of jobs within a ½-mile radius of fixed-guideway transit stops. This metric helped identify underserved job centers—employment hubs with poor transit coverage. The analysis included a count of CBGs with no jobs within critical transit buffers, highlighting unserved regions in Charlotte's current transit network.

To further explore these disparities, a threshold analysis was conducted to identify CBGs meeting specific benchmarks for transit access. The number of CBGs with at least 25%, 50%, and 75% of jobs within a ½-mile radius was calculated. This threshold analysis provided insights into how transit accessibility is distributed across Charlotte and pinpointed neighborhoods lacking sufficient coverage.

Visualizations, including histograms and box plots, illustrated the distribution of job accessibility across CBGs. Histograms highlighted the prevalence of low-access conditions, while box plots exposed outliers and variations in coverage. This step clarified average and extreme cases of transit-based job accessibility.

To better quantify these disparities, a metric called the Underserved Proportion was created, defined as 1 minus the percentage of jobs within ½ mile of a fixed-guideway transit stop. This metric reflected the share of jobs inaccessible to fixed-guideway transit in each CBG. Multiplying this value by the total number of jobs yielded the number of underserved jobs per CBG, allowing for the identification of areas with high concentrations of jobs lacking transit access. CBGs were then ranked based on the number of underserved jobs, identifying critical zones for infrastructure improvement.

We created choropleth maps using GeoPandas and Matplotlib to visualize spatial employment patterns. Employment data was merged with CBG shapefiles, enabling spatial visualization of job density, transit proximity, and underserved job locations. These maps effectively highlighted clusters of CBGs with significant transit gaps and job concentrations, providing a visual narrative of transit accessibility disparities.

To address the second research question—"What types of businesses are common in areas with poor transit access, and how can they be better connected?"—we conducted a spatial analysis

of job distributions across all CBGs. CBGs without access to fixed-guideway transit were isolated by filtering for those with an Underserved Proportion of 1.

The analysis focused on the distribution of eight primary job categories: Retail, Office, Industry, Service, Entertainment, Education, Health, and Public. For each category, the proportion of jobs in no-transit-access CBGs relative to the county-wide total was calculated. This was achieved by dividing the total jobs (of each job type) in underserved CBGs by the overall count of each job type across all CBGs. We visualized these proportions using a bar chart to illustrate the concentration of each job type in underserved areas.

To explore disparities for transit-dependent populations, we examined low-wage worker concentrations and zero-car households in transit deserts. CBGs with more than 40% low-wage workers and over 15% zero-car households were identified. These socioeconomic variables were mapped to visualize gaps in transit infrastructure for populations most reliant on public transportation.

All choropleth maps in this study were layered with the current LYNX transit system to show real-time transit access disparities.

4 Results

Our analysis of job accessibility in Charlotte's fixed-guideway transit system reveals significant disparities, particularly in Census Block Groups (CBGs) located far from transit stops. An initial histogram of ½-mile proximity thresholds revealed that 83% of Mecklenburg County's CBGs (463 out of 554) had zero jobs within a ½-mile radius of a fixed-guideway transit stop. This finding underscores the magnitude of Charlotte's current transit coverage gaps, indicating that most employment centers are not easily reachable by the city's current transit infrastructure.

Further investigation of job accessibility metrics identified only 12% of CBGs (68 out of 554) with at least 25% of jobs within ½ mile of a fixed-guideway transit stop. Moreover, just 4% of CBGs (24 out of 554) had 75% or more of jobs within this critical radius. These results suggest that only a small fraction of employment hubs are well-served by Charlotte's fixed-guideway transit system, leaving substantial portions of the workforce dependent on personal vehicles or facing lengthy commutes.

Spatial analysis using choropleth maps revealed clear geographic patterns in employment concentration and transit access. High-employment clusters were identified around major economic zones, such as the airport (West), University City (Northeast), and Carowinds (Southwest) (Figure 1). The limited infrastructure reach became evident when these employment clusters were overlaid with current fixed-guideway transit lines (Figure 2). The light rail (LYNX) corridor, which runs linearly through the city, leaves large segments of employment hubs disconnected from fixed-guideway transit, particularly in the southwest and northern regions.

The analysis revealed that nearly 80% of Industry and Retail jobs are located within CBGs with no transit access, indicating a heavy reliance on personal vehicles or limited mobility options for workers in these sectors. This trend was also significant in the Education, Health, and Entertainment sectors, with approximately 70% of their jobs in these underserved areas. Conversely, the Public
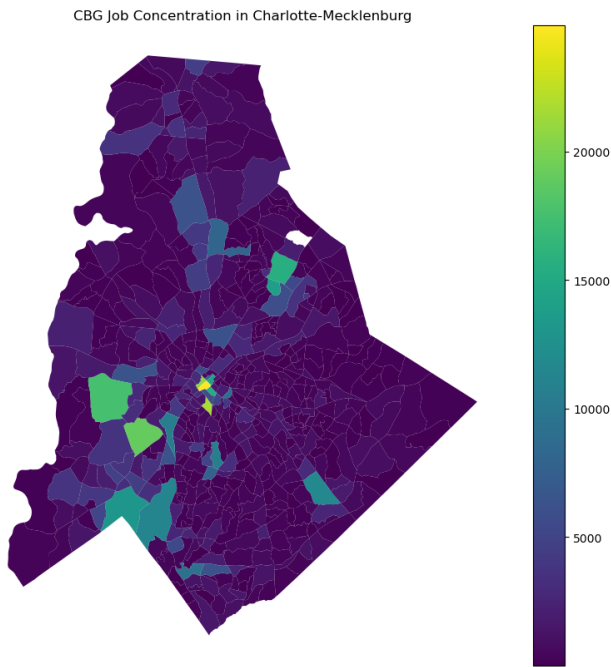
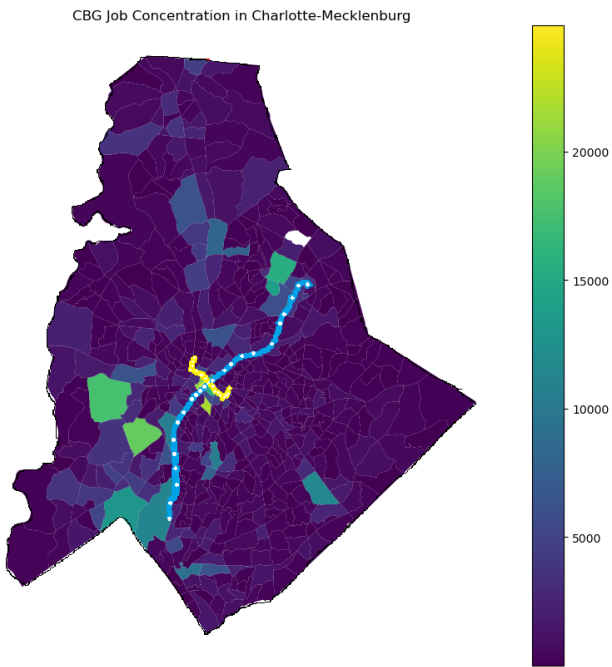**Figure 1: Job concentration for all CBGs within Mecklenburg County**

Figure 2: Job Concentration for Mecklenburg County CBGs, with the reach of the current light rail and the CBGs it services

sector showed minimal representation in transit deserts, reflecting its overall lower job count in the region and potentially more strategic placement.

Socioeconomic analysis of CBGs with high concentrations of low-wage workers and zero-car households revealed a pronounced spatial mismatch between these transit-dependent populations and accessible public transit infrastructure. CBGs with significant concentrations of low-wage workers were widely dispersed across the county, many of which are situated in areas with insufficient transit access (Figure 3).

In contrast, CBGs with over 15% of zero-car households were predominantly concentrated near the city center (Figure 4). The data reveal a clear pattern: the closer a CBG is to the city center, the higher the proportion of zero-car households. This pattern diverges in the "affluent wedge" region, where car ownership remains high despite proximity to the urban core. One outlier emerged near Tyvola Road, where a CBG far from the city center displayed the second-highest proportion of zero-car households, highlighting a critical gap in transit accessibility for this transit-dependent population.

Overlaying these findings with existing and planned transit infrastructure demonstrated that while upcoming expansions like the Silver Line and Red Line aim to address some underserved employment centers, such as Uptown, the airport, and Matthews, significant transit gaps remain in key areas, including Carowinds and Tyvola Road. This reveals an apparent spatial mismatch where some of the most transit-dependent populations remain disconnected from effective public transit solutions.
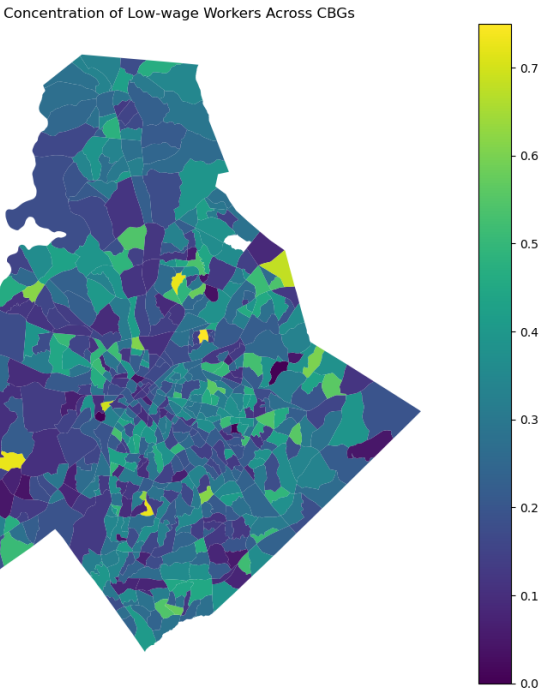

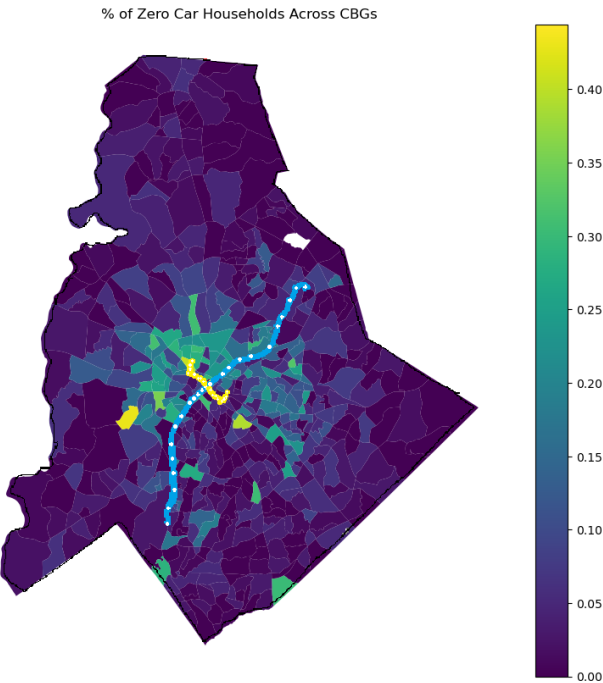**Figure 3: Proportion of low-wage workers across CBGs**

Figure 4: CBGs with high percentages of people who do not own a car. The current light rail route is to show access

Figure 5: Job Concentration in Mecklenburg County compared to the proposed Red and Silver lines. Blue and Gold lines are present for totality

5 Discussion

The findings of this study demonstrate that Charlotte's fixed-guideway transit system falls short in providing equitable job access across the city. While some employment hubs and Census Block Groups (CBGs)—particularly those in and around Uptown—are well-served by transit, 83% of CBGs have no jobs within a ½-mile radius of a fixed-guideway stop. This suggests that large portions of the city's employment landscape remain disconnected from the existing light rail network.

This lack of accessibility is not just a transportation issue—it is a structural economic barrier. Workers in industrial and retail sectors, who tend to be lower-wage earners, face especially limited options when transit is lacking. The clustering of these jobs in underserved areas means many workers must either endure long, inefficient commutes or are effectively shut out from those employment opportunities. This challenge is compounded for zero-car households, who rely entirely on public transit. While these households are mostly concentrated in the urban core, our spatial analysis highlights outliers—such as the Tyvola–Archdale corridor—where transit deserts exist despite clear demand.

Planned expansions, such as the Silver Line and Red Line, offer some progress by improving access to key areas like Charlotte Douglas International Airport and the Southeast Corridor, but they fall short of covering high-employment areas in the southwest—notably the Arrowood–Carowinds employment corridor and the Tyvola–Archdale area—which remain disconnected from both current and proposed infrastructure. Addressing these gaps would not only expand job access for underserved communities but also
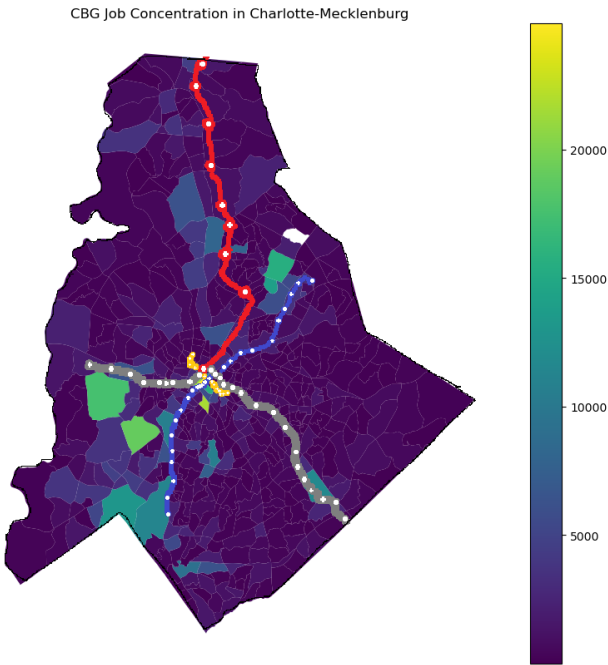
reduce walking distances between transit stops and major employment sites.

Our inclusion of socioeconomic data revealed a clear pattern: CBGs with high concentrations of low-wage workers and zero-car households frequently overlap with fixed-guideway transit deserts. Expanding transit infrastructure into these areas could play a critical role in advancing equity by connecting transit-dependent populations to job opportunities they might otherwise be unable to reach. To be effective, transit investments must prioritize both coverage and connectivity—ensuring the system works for those who need it most.

This study does have certain limitations. Our spatial proximity analysis measures straight-line distance ("as the crow flies") and does not account for the actual walking routes or barriers that may affect access. Future work could refine this with network-based walking distances for greater precision. Additionally, our focus on fixed-guideway transit excludes the role of buses and other flexible transit modes, which may currently provide some access to underserved areas. Incorporating these elements would help build a more complete picture of Charlotte's transit landscape.

6 Conclusion

These findings highlight the critical gaps in Charlotte's fixed-guideway transit network, which leaves many job centers poorly connected. This mode of transport particularly underserves the industrial, retail, and education sectors. The analysis emphasizes the need for strategic expansion of fixed-guideway transit to reach such areas, particularly along key corridors and major employment hubs like

the Arrowood-Carowinds and Tyvola-Archdale areas. To enhance accessibility, it is equally important to improve "last-mile" infrastructure, ensuring that residents can easily travel from transit stops to their places of work.

Additionally, targeting investment into transit-dependent communities is crucial to reduce the mobility barriers faced by low-income workers and those without car access. Expanding and enhancing transit infrastructure to connect underserved job centers to a willing workforce can create a more equitable and sustainable urban future for Charlotte. The findings from this analysis should inform future urban planning and transit development, ensuring that all residents have access to the jobs they need.

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