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Microtransit Demand Analysis and Validation: An Innovative Approach

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Abstract

Microtransit, a demand-responsive, flexible, and cost-effective transportation mode, showcases enhanced urban mobility and can replace traditional fixed-route transit. As the implementation of microtransit requires substantial investment and operational cost, a thorough demand analysis is required to identify the appropriate transit need areas. This study addresses the gaps in the limited microtransit demand studies by proposing an innovative technique that integrates diverse demographic, geographic, traffic, and socioeconomic factors into transit propensity analysis. The proposed methodology of this study aims to provide a more accurate and tailored assessment of the micro-transit propensity score by considering diverse influencing factors and ultimately estimating the propensity score at any geographical unit level. The proposed methodology is validated through a case study of East Baton Rouge Parish, Louisiana, using data analyzed at the census block group level. The result of the study provides valuable insights for planners and policymakers seeking to optimize microtransit deployment and enhance transportation equity, efficiency and improved access to daily life activities.

Keywords

Microtransit, Propensity Score, Mobility, Demographic Factors

1. Introduction

Micro-transit, a type of demand-responsive transit system, is getting more and more attention as a possible solution for enhanced urban mobility and reducing carbon emissions. Unlike fixed-route transit services, micro-transit has flexible routes and plans that change based on the ridership demand for a particular period. This mode of transportation is very efficient and user friendly, especially in areas with low to moderate population densities or where conventional transit systems may not be viable.

Determining the most suitable locations for implementing micro-transit services is crucial due to the initial investment and operating costs associated with these systems. A lack of thorough micro-transit demand analysis can lead to a unwellness to pursue regional objectives and the premature closure of the project, resulting in financial losses and unmet transit needs. Historically, only a limited number of studies have focused on micro-transit demand analysis, and many of these have overlooked the importance of considering various demographic factors when estimating propensity scores. Additionally, there is a research gap regarding the identification of the most influential factors for optimal demand analysis.

This study proposes an innovative methodology for estimating micro-transit demand by incorporating various types of demographics, geographic, traffic and socio-economic factors into the propensity analysis. By including these considerations, the study aims to provide a more accurate and tailored assessment of micro-transit potential. Furthermore, the research introduces a systematic approach to identify and prioritize the most influential factors for demand analysis, ensuring that micro-transit services are implemented in locations where they are most likely to be successful and sustainable.

This research provides an opportunity to validate the proposed methodology by applying it to evaluate micro-transit needs in East Baton Rouge Parish, a significant part of the Baton Rouge Metropolitan Area, Louisiana, the United States of America. The parish, characterized by a diverse landscape of densely populated urban centers, suburban neighborhoods, and rural towns, presents unique transportation challenges that necessitate transit solutions. The area experiences significant intra-parish movement due to the presence of major educational institutions, commercial hubs, and medical centers, and the siting of Interstate 10 (I-10) through the parish contributes to considerable traffic congestion. This highlights the need for a robust and flexible transit system. By focusing on census block groups as the unit analysis, the study aims to identify the specific factors influencing transit demand and provide a comprehensive understanding of the area's transportation need dynamics. This detailed analysis will enable the development of micro-transit solutions that are precisely tailored to the distinct needs of each community, ensuring that the transportation system effectively addresses the needs of all residents.

The research will employ a multifaceted methodology, combining quantitative data with qualitative insights. It considers a range of factors, including demographic, socio-economic, geographic, and behavioral variables that influence transit needs and preferences. By analyzing these variables at the census block group level, the study aims to identify areas with the highest transit demand, pinpoint underserved areas, and propose effective micro-transit strategies. This comprehensive approach will help enhance coverage and improve service efficiency, ensuring that micro-transit solutions are both viable and beneficial for the communities they serve. The research process is shown in Figure 1.

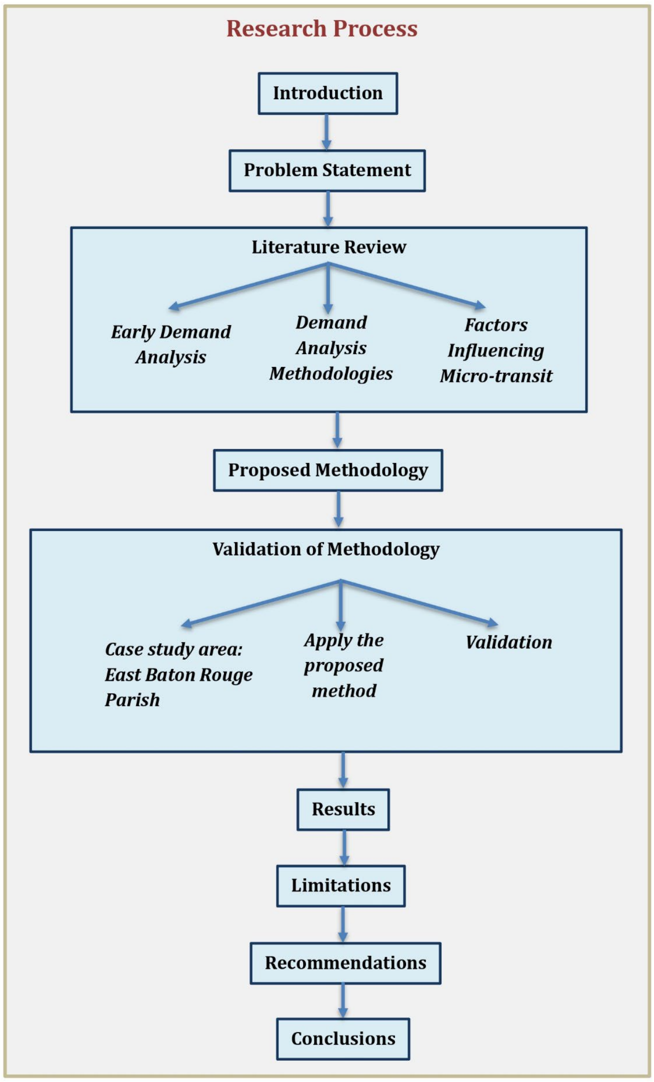


Figure 1. The flow diagram of the research process.

2. Problem Statement

Though micro-transit is becoming a more popular mode for ensuring quality mobility in urban areas, there is a lack of comprehensive research for this efficient mode of transport. The local and state agencies, including private companies, face problems in identifying the most suitable areas for the Mico-transit implementation. The local, state and federal funding is very limited and requires maximum utilization of the limited av available dollars. However, there is very limited research on micro-transit demand analysis to solve this issue. A few studies have found important factors that affect transit demand, but these factors are not fully combined into a single analysis framework that can help with planning and implementing micro-transit. This study aims to fill in these gaps by doing a thorough demand analysis at the census block group level, using a wide range of demographic, socioeconomic, geographic, and behavioral factors.

3. Literature Review

Mico-transit is a flexible and demand responsive transportation mode that links the traditional fixed route mode and ride hailing. With the growing urbanization and congestion, the demand for micro-transit is increasing rapidly. The metropolitan and urban areas are using micro-transit as a great program to reduce the ongoing congestion. The local governments are also considering this program to provide transportation to underserved areas and elderly citizens. However, conducting the micro-transit demand analysis is challenging due to user behavior, dynamic nature of transit, correct use of demographic, economic and traffic factors, and the target populations.

3.1. Early Demand Analysis Methods

The early micro-transit demand analysis was based on the traditional four steps of travel demand modelling, which are trip generation, trip distribution, mode choice and route assignment [1]. However, this traditional method is macroscopic and fails to capture the flexible and real-time responsiveness character of micro-transit. For example, Cervero showed the limitations of static models in predicting flexible modes [2]. There are some other models such as Agent-based modeling (ABM), which simulates individual traveler's decision and Discrete choice models (DCMs) that use logit models, are promising alternatives for micro-transit demand analysis. But these models require extensive data calibrations and scaling in dynamic environments which lead to highest cost in model development [3] [4]. Consequently, it is common practice for agencies to use mesoscopic models or simplified discrete choice frameworks, which balance a moderate model cost with enough behavioral granularity. This way, agencies can perform in-depth analyses without using a lot of resources for fully dynamic or agent-based systems.

3.2. Demand Analysis Methodologies

Robert Bush used a standardized method to rank the most transit need areas based on the propensity score [5]. The author used eight demographic factors and one geographic factor in census block group level to estimate the propensity score. Using ArcGIS natural breaks and weighing the factors the author estimated the propensity score. The method addresses the inconsistency in existing methods by incorporating NPTS studies and TCRP Report 28 and underscoring demographic factors in analysis. While the method is appropriate for local transit agencies and urban agencies, it does not identify commuter services.

Pulugurtha and Nambisan conducted research to automate the evaluation of the locations of Transit Service Facilities (TSFs) along a route to using GIS software [6]. The study focused on the end user accessibility by establishing a spatial extent threshold which is quantified on walking distance and walking time considerations. Following the simulation of TSF locations in the existing road and transit network, the methodology defines the accessible zone around a TSF arc using GIS. After that it used 1990 census data on Traffic Analysis Zone (TAZs) level using various demographic factors to perform a spatial analysis and estimate the index of transit potential and locate and select the TSFs.

The research paper titled "Getting People Around After the Trains Stop Running" evaluated the late-night transit user demand analysis focusing on work and entertainment trips [7]. The authors used Census Transportation Planning Package data to identify late night work trips and combined demographic factors to develop late-night Transit Propensity Index (TPI). The research team compared the TPI with existing ridership by applying a stop level regression analysis to validate the TPI.

Joel Volinski conducted research under Transit Corporative Research Program [8]. The report of the program provided an overview of the demand response transit (DRT) and micro transit services across the nation by analyzing 22 transit agencies. The study finds that micro-transit employs different methods, such as point deviation, route deviation, and on-demand scheduling with an aim to enhance operational efficiency. The report further emphasizes the use of new technologies such as real-time routing algorithms, mobile applications, and automated scheduling. The report suggests that micro-transit can be cost effective alternative to fixed route transit, while knowing ridership might be a challenge. Also, the report finds that agencies typically consider flexible policy making and data driven decision making to maximize service operation level.

The "TCRP Report 28" performed research on the community that improved ridership or expanded the market by planning and implementing innovative user concentric strategies [9]. The research team found that five categories, such as economic, demographic, social, land use and transit policy mostly affect the demand. The study mentioned that Reverse-commute services, Services to large employers (including universities), Vanpool incentives, Route restructuring, and Feeder services can affect the largest numbers of riders. The study also recommended various strategies for agencies and industries, remarkably refining market by studying ridership patterns.

The Sustainable Montpelier Coalition (SMC) explored feasibility and implementation of microtranit by conducting a demand analysis in Montpelier, Vermont [10]. The report outlines demographic, traffic and socioeconomic factors with various data sources such as travel surveys, census data, and transit ridership reports to develop a demand model with GIS-based spatial analysis.

One of the earlier research projects conducted by Christiansen and Maxwell recommended methods for estimating vanpool demand primarily using Houston, Texas data [11]. The paper used different data, such as vanpool, census, contraflow lane data, origin-destination surveys, and home mail-out surveys, for the demand analysis. It examined regression models, stated-preference surveys, and GIS-based spatial analysis for the demand analysis.

3.3. Factors Influencing Micro-Transit Demand

Researchers used various demographic, socioeconomic, land use and transportation data for the demand analysis. The most frequently used influencing factors for propensity analysis are population density, zero-vehicle households, mobility limitations, work disabilities, minority populations, recent immigrants, low-income households, females, commuter trips, travel patterns, service trips, low income workers, household cars, racial data, woman, Immigrants (under 10 years in the United States), and Workers with mobility or work limitations [5] [7]-[9].

4. Methodology

The proposed methodology comprises 6 steps from the selection of contributing factors to visualizing the data. The selection of contributing factors is crucial and comprises several steps. The flow diagram of the methodology is shown in Figure 2.

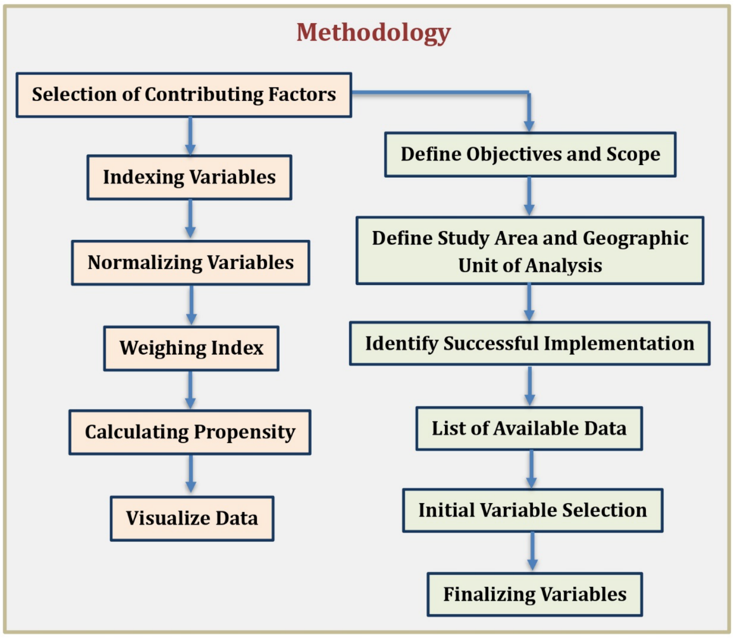


Figure 2. The flow diagram of the methodology.

4.1. Selection of Contributing Factors

Step 1: Define Objectives and Scope: This step builds the foundation of the entire micro transit demand analysis. There are several factors that need to be considered as follows:

1) Evaluation of existing market: The evaluation of existing market includes the current number of ridership, ridership demographics, trip patterns and gap in ex-

isting service. This evaluation enables an agency to plan and program for micro-transit demand analysis and implementation.

2) Effectiveness of existing service: From the perspective of local government, state transportation or transit department, performance matrices are the most useful tool to evaluate effectiveness. Performance matrices can be evaluated for the existing condition to evaluate the effectiveness of a transit system.

3) Scope of Potential Improvement: The scope of the improvement can be determined based on the evaluation and effectiveness of the existing markets. If it is determined that improvement is required, then the demand analysis can be pursued.

4) Estimate Potential Ridership: Additional targeted research on the estimation of the potential ridership from public transit ridership database is crucial. Different transportation planning software, such as TransCAD/CUBE can be used to forecast the future ridership in a region.

5) Identification of Key user groups: Identification of the population cohorts or user segments is vital as it determines the ridership and success of a microtransit program. The key user groups could include neighbors, workers, tourists, students, seniors, disabled people, or people from certain income groups. This effort is key to getting an accurate view of microtransit viability.

Step 2: Define Study area and geographic Unit of analysis: The determination of the type of study area, for example, State, Metropolitan Area, County, City, and Neighborhood is significant as it determines the scope of the study and selection of the suitable variables. The serving area of an institution largely influences the determination of the study area; for example, a Metropolitan Planning Organization (MPO) largely focuses on the metropolitan planning area, the city focuses on the city boundary, and the county focuses on the county boundary. In practice, the trips are not limited to a particular boundary, *i.e.*, the generation of a trip might be a particular city, but trip attraction might come from a different city. This implies that the larger the study area, the greater the opportunity of finding suitable and successful micro-transit need areas increases. A city or parish can partner with another city or parish for the demand analysis and successful implementation of the micro-transit study. Also, there are opportunities to use regional data, such as Travel Demand Model (TDM) efforts, can help refine both the boundaries and population to be studied.

The Transit Cooperative Research Program (TCRP) Report 28 (Transit Markets of the Future) and 3 (Workbook for Estimating Demand for Rural Passenger Transportation) provided the guidelines for the county level. Montpelier On-Demand, Micro-Transit Market Analysis and Development Plan (2019) performed the calculation on the City level. However, the calculations could be scaled up to perform analysis on any area level. Where the bigger analysis area enables finding the most suitable areas, it also increases the calculations. Based on the evaluation and effectiveness of the existing market, some unnecessary analysis areas can be filtered out to decrease the calculations.

Step 3: Identify successful implementation: Reviewing existing studies, reports, and case studies on micro-transit implementation in a similar study area is the best practice before starting a microtransit demand analysis. Research on the influencing factors of a similar type of study area also enables an agency to select the most suitable factors for its own study. Additionally, this literature review enables an agency to take different implementation strategies, such as service model, target user groups, technology, and so on.

Step 4: List of available data: The list of available data is very important, as the inclusion of a significant influencing factor primarily depends on the data availability. An agency might not want to include a factor for which data might not be available. It is good practice to list the available data for the study and select the most appropriate factors from the comprehensive list.

According to the TCRP Report 28: Transit Market for the Future, five aggregated categories tend to influence the transit demand the most, which are: 1. Economic, 2. Demographic, 3. Social, 4. Land use, and 5. Transportation Policy. The report also says the ridership increase occurs in the 10 transportation niches, such as 1. People with disabilities, 2. People aged 17 to 25 (particularly university students), 3. Children aged 5 to 12, 4. Blacks (particularly inner-city residents), 5. Hispanics, 6. Immigrants, 7. People aged 65 and over, 8. People with high incomes, 9. People aged 50 and over, and 10. Men.

Step 5 initial variable selection: This step includes compiling a list of potential variables based on the list of available data from step 4, literature review on similar agencies, and interagency shot/long term goals. The variables can be categorized in different groups such as demographic, geographic, socioeconomic, environmental, infrastructure, policy, and technology to ensure that the list of initial variables covers all aspects of planning.

Step 6 Finalizing variables: The variables can be finalized based on the initial list and stakeholder's input, including citizen's input. The following factor can be considered while finalizing the variables.

1) Data availability: It must be confirmed that reliable and relevant data is available for each selected variable for the selected geographical unit level.

2) Feasibility of data: Ensure that the chosen variables can be measured and analyzed effectively.

3) Multicollinearity Check: It is a good practice to analyze correlations between variables to avoid redundancy and ensure the variables make a robust demand model.

4) Relevancy of the Variables: Ensure each variable is directly related to the goals of the microtransit demand analysis.

5) Equity and Inclusion Metrics: Ensure the variables capture low income and underserved populations.

6) Consideration of local context: The local context of the variable is very important. For example, the presence of a growing number of elderly citizens might make the "elderly population" a significant factor for the local context.

4.2. Indexing Variables

Indexing is a technique used to transform different sets of datasets with various ranges into a standardized numerical score. This technique allows different factors to be compared, analyzed, and seen on a single scale. Indexing involves assigning a numerical value or score to a particular factor to represent that factor's relative magnitude or position within a given data set, and the factor is converted to a standardized numerical value.

In practice, each factor or variable in the dataset is evaluated based on its observed values across different geographical units. For a given variable and corresponding dataset, the variable is categorized into any number of categories between the highest and lowest value factors. For instance, for a category of 5 for the factor "population density", the geographical units with the lowest population density might be categorized by "1", and the units with the highest population density might be categorized by "5". The TCRP report 28: Transit Markets of the Future has some default indices for the Sex, Race and Ethnicity, Vehicle ownership, Age of worker, education for different cohorts for metropolitan transit use with different population variations. These indices can be directly incorporated in practice.

household income, Immigration status and Limitations

The selection of the number of categories is flexible and must be guided by the objectives, goals, stakeholders' input, and data availabilities with an agency. While five categories (scores from 1 to 5) are commonly used, an agency may choose to use more or fewer categories based on the level of detail required for the analysis.

Different methods can be applied for the indexing of variables such as state classification rule and Jenks natural breaks. In state classification rule, the range of dataset for a given variable is divided into an equal-sized intervals, which is predetermined. In this case, each interval acts like a category and each data of a given variable is assigned to a category based on the range of the category. On the other hand, Jenks Natural Breaks is a more data driven approach. This method identifies natural categorization for a variable for a given data range, where it minimizes the variation in each category and maximizes the variation between categories.

4.3. Normalizing Variables

Several influencing factors contribute to the propensity score, where the unit and scale of the values are different. Index normalization converts variables into a standard scale or range. Index normalization ensures that each variable has an equal influence, corrects outliers, and aligns data to a standard scale. Also, normalization transforms the intra-factor data points to a uniform scale and enables transportation planners to map and identify the transit areas confidently.

Normalizing values takes the inputs of raw indexed values and transforms them into a common standard where the inputs of each variable are proportional and interpretable. The method ensures that no variables are overanalyzed. For example, the numeric value of population is very large compared to the numeric value of congestion. In this case, there might be a chance for the population to be over considered. Normalization converts the population and congestion into a common scale and eliminates the overrepresentation bias. It also helps to control the impact of outliers, so that demand factors are looked at fairly across different geographic areas, such as block groups.

For the index normalization, the ratio of each scored value to the total value was taken, and finally, the ratio was multiplied by 100. The following formula is used for the index normalization.

$$\text{Normalized index} = \frac{\text{Index in block group 1}}{\text{Index value of block groups}} \times 100 \tag{i}$$

Here, "Normalized Index" refers to the Normalized value for a particular factor. "Index in block group 1" refers to the numeric index value for a particular factor and particular block group. The "indexed value of block groups" represents the total number of indexed values of all block groups.

4.4. Weighing Index

Weighing index refers to assigning weights or importance to individual values. All selected factors do not have an equal influence on the propensity index. So, weighing is conducted to emphasize the contribution of different factors individually and ensure that the data represents the population. The "TCRP report 28: Transit Markets of the Future- The Challenge of Change" has some default weighting values for several factors based on the location and demographics of the study area

In the microtransit demand analysis, weighting index is totally customized. The user has the total freedom to weigh the index as per their agency, demographic, and stakeholders, including citizens' requirements. For instance, there might be more traffic congestion and lower minor population in a study area, and both values are included in the influence factors. In this case, traffic congestion shall have a higher weight compared to the minor population in the proportional contribution of the values. Weighing index should be a true selection of the needs and preferences of the targeted users, usually captured during public outreach.

Additionally, the weighting assignment in this study is based on both historical cases and current practices. The TCRP Report 28 emphasizes the importance of adapting different transit strategies to specific service, demographic, and geographic settings. It suggests that different factors should be weighted depending on the type of people being served, which strongly supports customized weighting instead of using a uniform weight. Also, agencies should consult local stakeholders and conduct outreach events to incorporate community demand in weighting factors. If stakeholders' input is not feasible, a sensitivity analysis should be applied to evaluate the effect of different weightings on results. These procedures ensure the transparency and credibility of the analysis.

4.5. Calculating Propensity

The propensity index is the ultimate variable that is used to visualize the transit needed areas at any geographical unit level. The propensity is one single numeric value for each geographic unit that represents all the influencing factors. The propensity score is calculated using the following proposed formula.

$$\text{Propensity Score}_i = \frac{x_1}{X_1} * \text{weight}_1 + \frac{x_2}{X_2} * \text{weight}_2 + \cdots + \frac{x_n}{X_n} * \text{weight}_n \quad \text{(ii)}$$

where,

i denotes unit area, for example, census block number.

$1, 2, \cdots, n$ denotes the Factor number

$X_1, X_2, \cdots, X_n$ denotes the summation of the indexes of a factor for all census group block groups

$x_1, x_2, \cdots, x_n$ denotes the index value of a factor, *i.e.*, population density, low-income HH, etc., in census block i.

4.6. Visualize Data

Developing a thematic map for all factors in the GIS platform is a good practice to understand the impact and distribution of the factors throughout the area. This map also serves to authenticate the appropriateness of selecting a specific factor for the demand analysis. Finally, a propensity map shall be created in a GIS platform, and the suitable regions for micro-transit demand will be selected.

5. Case Study

5.1. Study Area

East Baton Rouge Parish in Louisiana is the study area chosen for this micro-transit demand analysis, which is a significant and dynamic region within the Baton Rouge Metropolitan Area. This area includes the downtown core of Baton Rouge, which serves as the central business district and a hub for economic activities, cultural events, and government operations.

East Baton Rouge Parish encompasses diverse neighborhoods, each with unique characteristics and transit needs. The parish is a critical focal point for transportation planning due to its varied land use patterns, ranging from densely populated urban areas to more suburban and rural communities. This diversity makes it an ideal candidate for analyzing micro-transit demand, as it presents a microcosm of broader metropolitan challenges and opportunities.

Additionally, East Baton Rouge Parish is home to major educational institutions, medical centers, commercial zones, and recreational areas, all of which contribute to significant intra-parish travel. The presence of these destinations necessitates a robust and adaptable transit system to meet the varied mobility needs of residents and visitors alike.

5.2. Unit of Analysis

The census block group is the unit of analysis for this micro-transit demand analysis. Census block groups offer a granular level of data that allows for detailed analysis of the various factors influencing transit demand. By focusing on census block groups, an agency can accurately estimate the propensity for micro-transit services on a smaller scale, providing precise and actionable insights.

Census block groups are particularly advantageous for this type of analysis due to their relatively small size, which ensures that the data collected reflects the specific characteristics of local areas. This level of detail is crucial for understanding the nuanced variations in transit demand across different neighborhoods and communities within East Baton Rouge Parish. It enables the capture of diversity in demographic, socio-economic, geographic, and behavioral factors that influence transit needs and preferences.

5.3. Selection of the Influencing Factors

The section on demographic factors involves identifying key variables that control the potential needs of the micro-transit in a particular region. A literature review was conducted to evaluate the most common and impactful factors for the demand analysis. It was found that the demographic factors vary with study areas and mainly depend on land use, urbanization, population characteristics, household characteristics, employment, and congestion level. In addition, the "Transit Market of the Future- The Challenge of Change report was thoroughly reviewed, where some factors were considered based on the population density of an area, *i.e.*, low, medium, and high; average transit use; service environment; and types of trips. After that, the target area was thoroughly analyzed to understand the demography and geography clearly. Moreover, the stakeholders' inputs were considered for the selection process. Finally, thorough planning and judgment were applied to select the final factors. Eleven factors were selected based on the four categories: population, Household characteristics, Employment, and Congestion. All the factors were converted to per unit square mile. For example, the population value was calculated at the census block group level, and the population was then divided by the area of the census block group to estimate the population density per square mile. The selected variables are as follows:

1) Population Density
2) People with Disability
3) Young population (18 - 24 inclusive)
4) Minority
5) Low-income HH (<22 k)
6) Zero-vehicle HH
7) Employment Density
8) Low-wage employment (<22 k)
9) Job access score
10) Level of congestion
11) Single Occupancy Vehicle.

5.4. Data Sources

Five data sources were used in this study, which are reliable and well-known. The data sources are as follows.

1) **Census:** Population density and young population (18 - 24, inclusive).

2) **American Community Survey (ACS):** Disabilities, minority, low-income HH < 22 k, zero vehicle HH, and single occupancy vehicles.

3) **Longitudinal Employer-Household Dynamics (LHED):** Employment density and low-wage employment (<22 k).

4) **Center for Neighborhood Technology (CNT):** Job access score.

5) **Regional Travel Demand Model:** Congestion.

5.5. Indexing Variables

Indexing refers to assigning a numerical value or score to represent that factor's relative magnitude or position within a given data set. So, each factor was converted to a numerical value. To proceed, all data points were categorized into five classes, spanning the range between the factor's highest and lowest values. Each category was assigned values 1 to 5 based on the value of the category, *i.e.*, the lowest category value was scored 1, and the highest category value was scored 5.

5.6. Normalizing Variables

Index normalization is used to transform variables into a standard scale or range. Index normalization ensures that each variable has an equal influence, corrects outliers, and aligns data to a standard scale. For index normalization, the ratio of each scored value to the total value was calculated, and then the ratio was multiplied by 1000. Equation (i) was used to perform the index normalization.

5.7. Weighing Index

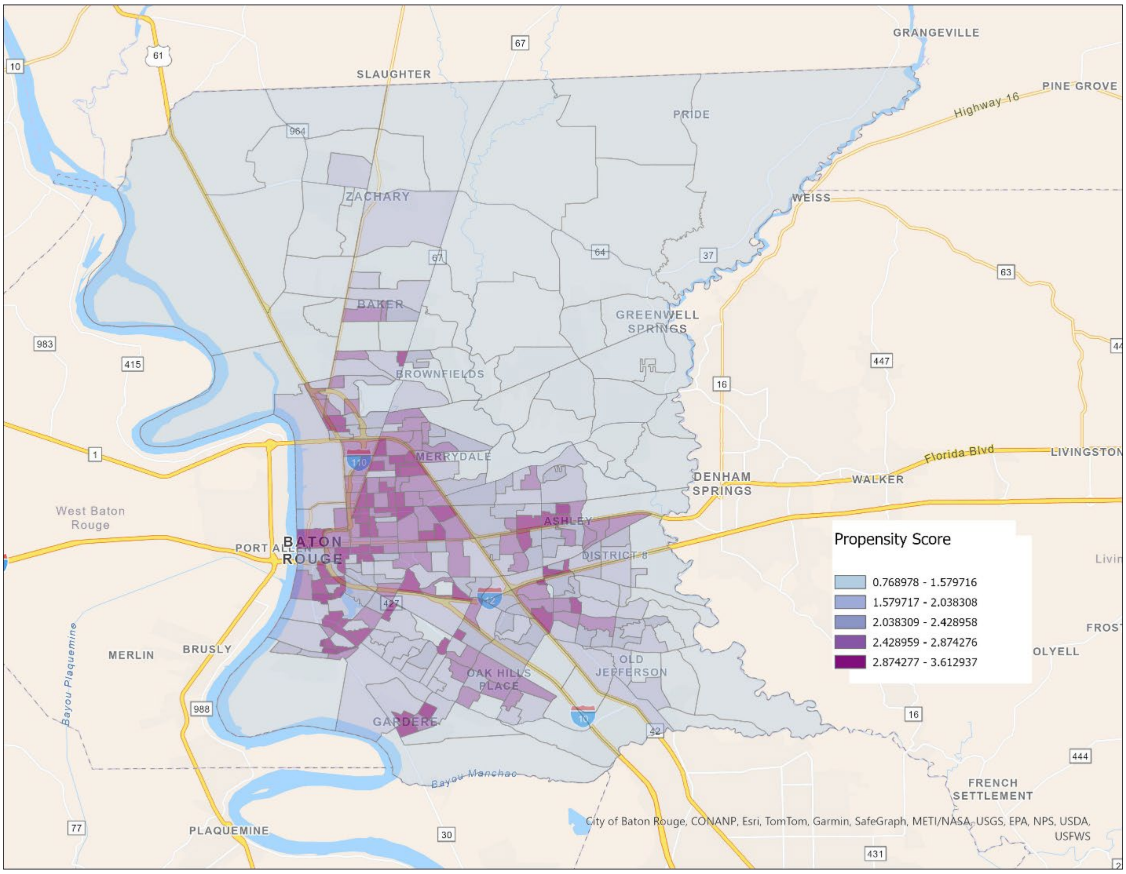
Weighing was conducted to emphasize the contribution of different factors individually and ensure that the data represents the population. A total weight of 1000 was applied to all the factors. According to the Building Transit Ridership study, 37 percent of transit variation is determined by the population density. So, a weight of 300 was applied to the population density. The micro-transit facilities are mainly for households that do not have a car. So, the second highest weight of 250 was applied to the zero vehicle HH. The East Baton Rouge Parish has a significant minority population. So, the third highest weight of 100 was applied to the Minority factor. Based on the judgment, the rest of the weight was distributed to the remaining factors.

5.8. Calculating Propensity Score

The propensity score calculation is crucial as it is used to visualize all factors and identify the areas that need transit. The propensity score was calculated using the formula (ii).

5.9. Visualize Data

The propensity score is mapped and visualized in the ArcGIS Pro software. The map is shown in **Figure 3**.



Source: Census, ACS, LHED, CNT, BRMPO.

Figure 3. Visualization of the Transit Propensity Score.

6. Result

6.1. Analysis of Propensity Score and Validation

The study indicates that the propensity score for microtransit demand analysis is typically higher in areas closer to downtown Baton Rouge and across several major highways within East Baton Rouge Parish. The highest cohort of propensity scores (ranging from 2.87 to 3.61) mainly concentrated in the downtown area, along U.S. Highways 190/61, and along Plank Road. Downtown Baton Rouge serves as a central business hub, with a high density of commercial activities and employment centers, which makes it a suitable candidate for microtransit implementation. Similarly, the U.S. Highway 190/61 corridor is a significant arterial route that supports hundreds of businesses and shopping centers, which further underscores its suitability for microtransit implementation. On the other hand, Plank Road serves a large portion of underserved and low-income communities, which is a suitable area for implementing the flexible mode of transit, such as micro-transit services.

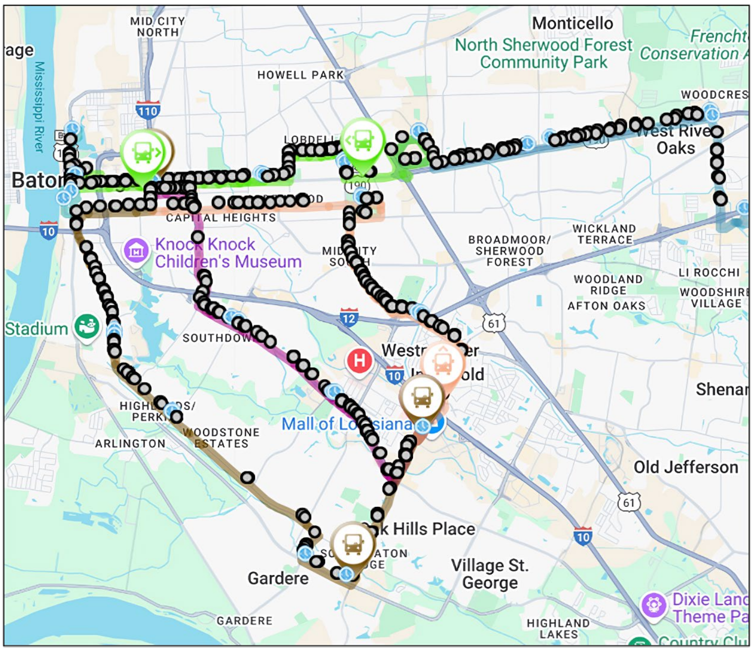
The second-highest propensity score cohort, ranging from 2.41 to 2.82, is found in areas adjacent to downtown, along U.S. Highway 190/61, Government St, Perkins Rd, and near the Oak Hills Place neighborhood. Oak Hills Place is a suburban area located in the southern part of the parish, bordered by Highland Road, Siegen Lane, and Bluebonnet Boulevard. Its moderate transit propensity reflects both residential density and proximity to key arterial roads.

The third-highest propensity score cohort (2.03 to 2.42) includes areas on the outskirts of downtown, along segments of U.S. Highways 190/61 and 42. U.S. Highway 42 is a major congestion corridor undergoing active development, indicating a potential future demand for flexible transit solutions, such as microtransit.

Overall, the spatial distribution of propensity scores supports the validity of the proposed microtransit demand analysis method for East Baton Rouge Parish. These findings highlight strategic areas for pilot implementation and further expansion of microtransit services.

6.2. Validation with Existing Transit Service

The current Capital Area Transit System (CATS) already offers transit service in the downtown area, especially along US 190 and Plank Road, which has the highest propensity score. Additionally, CATS offers transit services on Government Street, Perkins Road, and Bluebonnet Road, which have the second-highest propensity score. The Highland Road and Bluebonnet Blvd. cover the Oak Hills Place area. Additionally, there is a transit service along with LA 42 (partially), which has the third-highest propensity score. These indicate that the proposed method for estimating the transit need area is significantly valid. Figure 4 illustrates the existing CATS transit service on the top three propensity roads, validating the proposed method.



Source: CATS.

Figure 4. Existing CATS transit service in the top three propensity roads.

6.3. Recommendations

Although the research focused on microtransit demand analysis, the same procedure can be applied to demand analysis for most forms of transit services, such as bus rapid transit, fixed-route transit, paratransit, carpool/vanpool, as the study primarily focused on individuals who needed shared and affordable mobility services. In this case, the proposed methodology could be applied with a meticulous analysis to select the influencing factors and corresponding weights. The authors recommend using the most relevant factor for the demand analysis, rather than too many influencing factors, as this biases the propensity score. The selection of influencing factors must align with the scope and goals of the project as well as the vision of the agency. Also, using a feasible geographical unit is highly effective in finding the most transit-needed areas and increasing the accuracy of the analysis.

6.4. Limitations

Though the study identifies the most needed areas, it does not identify the data on the trip levels, *i.e.*, where the transit trips are generated and where they end. Further tools, such as census on the map, traffic counts, and a regional travel demand model, can be utilized to find the production and attraction of trips. Also, the research does not directly suggest the routes and numbers of trips for microtransit. A commuter data analysis will help to fill the data gap. The research suggests that transit needs areas are based on influencing factors and their corresponding weights, as considered in this study. It does not cater to other influencing factors, which may be applicable to other areas, regions, or modes of transit.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Miller, E.J. (2020) Travel Demand Models, the Next Generation: Boldly Going Where No-One Has Gone Before. In: Goulias, K.G. and Davis, A.W., Eds., *Mapping the Travel Behavior Genome*, Elsevier, 29-46. https://doi.org/10.1016/b978-0-12-817340-4.00003-6

[2] Cervero, R. (2002) Built Environments and Mode Choice: Toward a Normative Framework. *Transportation Research Part D*: *Transport and Environment*, **7**, 265-284.

[3] Agatz, N., Erera, A., Savelsbergh, M. and Wang, X. (2012) Optimization for Dynamic Ride-Sharing: A Review. *European Journal of Operational Research*, **223**, 295-303.

[4] Emtiaz, M., Imtiyaz, M.N., Majumder, M., Idris, I.I., Mazumder, R. and Rahaman, M.M. (2023) A Comprehensive Literature Review on Polymer-Modified Asphalt Binder. *CivilEng*, **4**, 901-933. https://doi.org/10.3390/civileng4030049

[5] Bush, R. (2011) A Proposed Methodology for Conducting Propensity Analysis to Identifying Areas of Transit Need. https://trid.trb.org/View/1224912

[6] Pulugurtha, S.S.N. and Shashi, S. (1999) Evaluating Transit Market Potential and Selecting Locations of Transit Service Facilities Using GIS. *Journal of Public Transportation*, **2**, 75-94.

[7] Dentel-Post, C., Cooper, D., Huang, Y., Crosley, S., Tolleson, M. and Carraher, M. (2017) Getting People around after the Trains Stop Running: Transit Propensity Index for Late-Night Service Planning. *Transportation Research Record*: *Journal of the Transportation Research Board*, **2649**, 97-105. https://doi.org/10.3141/2649-11

[8] Volinski, J. (2019) Microtransit or General Public Demand Response Transit Services: State of the Practice. National Academies. https://doi.org/10.17226/25414

[9] Rosenbloom, S. and Fielding, G.J. (1998) TCRP Report 28: Transit Markets of the Future, The Challenge of Change. Transit Cooperative Research Program, Transportation Research Board, National Research Council. https://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_28-a.pdf

[10] Coaiation, S.M. (2019) Montpelier On-Demand, Micro-Transit Market Analysis and Development. https://aii.transportation.org/Documents/Vtrans%20Montpelier%20On-Demand%20Microtransit%20Plan.pdf

[11] Christiansen, D.L. and Maxwell, D. (1982) Techniques for Estimating Vanpooling demand. National Academices Science, Engineering and Medicine. https://trid.trb.org/View/190973