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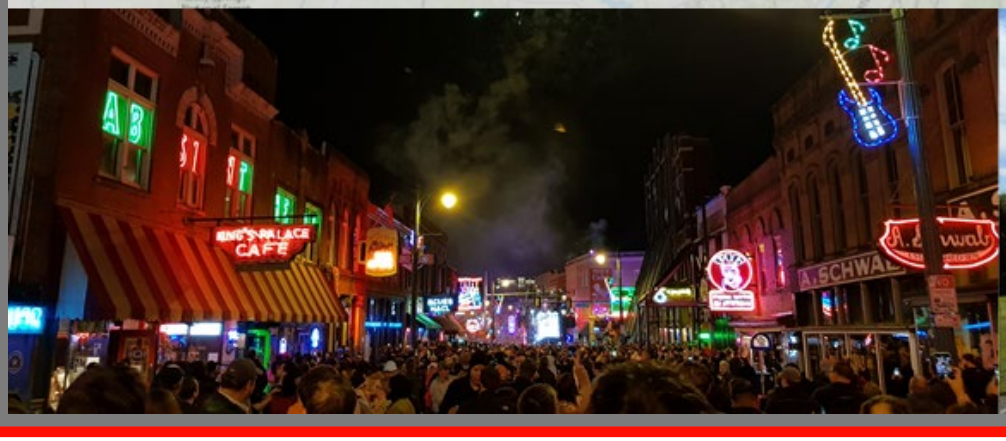

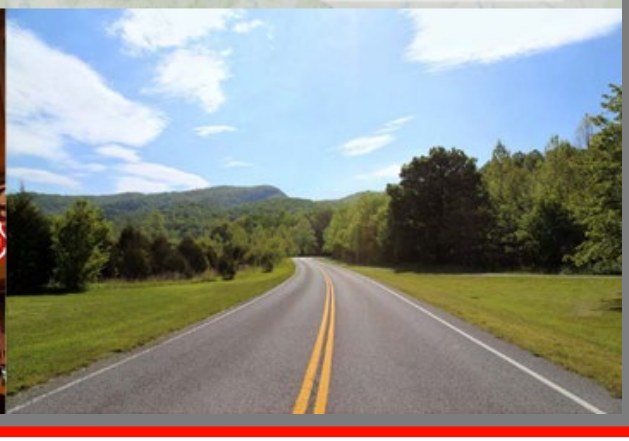

Towards Sustainable Tourism Transportation Systems and Services in Tennessee

Research Final Report from the University of Memphis | Sabyasachee Mishra, Mihalis M. Golias, Kakan Chandra Dey, Diwas Thapa, Md. Tanvir Ashraf | September 12, 2022

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16. Abstract

Tennessee is home to some of the most popular tourist destinations in the country and the tourism industry contributes considerably to Tennessee's economy. The industry in the state has grown considerably in the previous years and there is a need to identify and address issues related to transportation services to accommodate needs and requirements of tourists. This study identifies current deficiencies in the transportation system dedicated to tourists, and popular tourist destinations and origin markets. The findings from the study are used to provide policy level recommendations for improving tourism focused transportation system in the state. Results show that continued involvement of local and private tourism agencies in transportation project planning is needed, and the collaboration between the state DOT, state tourism office and tourism agencies should be encouraged for a tourism focused transportation system. Analysis of origin markets for major destinations show that most travels to Tennessee are attracted from bordering states. This can help agencies identify routes of interest for future improvement and expansion. Finally, based on our findings, key policy recommendations are presented to improve the current state of transportation system and services for tourism in the state.

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Executive Summary

Research need

Tennessee has a growing tourism industry, that contributes significantly to the state's economy, but also faces a growing transportation issue that needs to be addressed; congestion in major cities and tourist routes is a growing concern. Recent data from INRIX shows five of Tennessee's largest cities are ranked among the most congested in the US. Major cities in Tennessee are also home to some of the most visited and popular attractions in the country. While congestion can be addressed through infrastructure expansion such as the addition and widening of lanes, these alternatives are expensive. Introduction of a tourism-focused multimodal transportation system can offer a cheaper and more effective alternative to infrastructure expansion. Introduction and expansion of multimodal transportation services require identification of popular tourists' routes and attractions, transportation services available to tourists and their current deficiencies, and initiatives to address transportation issues faced by tourists. This research study undertook a detailed analysis of these aspects of the transportation system in Tennessee to provide the Tennessee Department of Transportation (TDOT) with policy level recommendations that would improve current transportation services available to tourists.

Research approach

A detailed review of the literature was completed to gather a synopsis of practices followed by states across the county related to planning tourism transportation projects, inter-agency collaboration, and tourism data collection and analysis. This helped to identify existing and recently adopted practices across the country.

An online survey was administered to state Departments of Transportation and transportation agencies across the country to gather better insight on their practices. Their approach to selection of tourism inclusive transportation projects, inter-agency collaboration, and use of tourism related data was explored. Using the survey data and tourism related statistics, an analysis was undertaken to classify states by tourism impact. This was done to identify practices that were common in high-tourism impact states versus other states. The results showed that states with high tourism impact (in terms of economy) had better inter-agency collaboration and tourism inclusive project selection process.

Tourists' trip characteristics are an integral part of long-distance travel demand modeling. Therefore, an online survey was conducted to obtain trip characteristics of tourists visiting the state. Additionally, their mode choice, travel distance and trip timings were also obtained using revealed preference questions. Findings from the survey suggested the most popular time of the year to visit the state is between April to August and people mostly preferred driving when traveling to the state. However, when the travel distance is over 500 miles, people's preference for air travel increased considerably. The findings from the survey were also used to analyze the impact of different scenarios on tourism. Specifically, the travel intention of tourists during the COVID-19 pandemic was studied using structural equation modeling and the collected survey data. Results suggested that better travel incentives and dissemination of pandemic related information would encourage people to travel more.

Using the national long-distance travel demand model, tourism travel was forecasted for four scenarios. These scenarios were: improved transit access, reduced air fare, reduced congestion on popular tourist routes, and increase in household income. Results from scenario analysis suggested that all these scenarios would have a positive impact on tourism. Notably, there would be a considerable reduction in use of cars with improved transit access and reduced air fare. On the contrary, people would drive more with an increase in household income.

Investigation of origin state from where people travel to major destinations in Tennessee was done using INRIX Trip Analytics to origin markets. Memphis, Nashville, Chattanooga, Knoxville, and Gatlinburg were chosen as destinations in our analysis since they are home to numerous attractions that are popular among out of state tourists. States closest to the destination were found to attract more trips to these destinations.

To identify current deficiencies in transportation services available to tourists, a survey was designed and administered to local and regional tourism agencies in the state. These agencies included chambers of commerce and tourism departments. The survey responses suggested that agencies desired dedicated budget to improve transportation services in their area and also preferred to collaborate with other agencies on project planning and selection. Additionally, the need for improved transit services, well maintained highways, tourism signage, and state level legislature and guidelines for inter-agency collaboration were identified as the most prevalent deficiencies experienced by local agencies.

The findings from these tasks were used to derive recommendations to TDOT which are summarized in the following subsection.

Key Findings

The key findings based on this study are concluded as follows:

- There is better inter-agency collaboration in states with higher tourism impact.
- Scenarios that encourage use of alternate transportation modes such as transit and air travel are expected to considerably reduce the use of cars.
- Local agencies opine that dedicated budget would better current state of transportation systems and services.
- A better collaboration between agencies at the state, regional and local level is needed to improve tourism inclusive project planning and improve related transportation services.

Key Recommendations

Transportation systems play a significant role in tourism development by connecting tourism-generating regions to destinations. The distribution, capacity, efficiency, and accessibility of transport services can not only affect how a destination develops but also visitors' mobility, and the connectivity of tourist experiences within destinations. However, an increased number of tourists can create challenges in terms of the sustainability of the tourism transportation system. Thus, proper planning and policy development are necessary to maintain the sustainability of the transportation system and destinations. This section presents policy and guidelines for sustainable tourism transportation services.

- TDOT and tourism agencies should collaborate more and share their projects and findings to identify future needs and current trends. Better collaboration is needed for collection and utilization of tourism travel data and tourism-based transportation project prioritization.
- TDOT should continue to engage the private sector in tourism transportation service planning and development. The private sector can play a key role in tourism-related transportation planning. The primary areas for private sector collaboration with TDOT and tourism agencies are private sector funding, marketing, data collection, and dissemination of tourism information.
- Tourism agencies at local and regional level should be provided more opportunities to participate in transportation project selection and planning process. This can be achieved by providing additional funds and grant to agencies to improve tourism transportation services at their level.
- A more detailed analysis of current state of transportation infrastructure in popular tourist areas and routes is warranted, particularly for attractions in Nashville, Gatlinburg, and Pigeon Forge. Tourists accessing attractions in these destinations have limited options; better access through public transportation is needed in these cities.
- Most out-of-state tourists vising destinations in Tennessee are from nearby states. Major routes that serve tourists traveling from bordering states should be given preference in terms of timely repair and maintenance.

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Chapter 1 Introduction

1.1 Problem statement

Tennessee is home to several iconic tourist destinations and attracts millions of tourists every year. The tourism industry in Tennessee outperforms many states in key indices such as travel expenditure, payroll, jobs, and tax revenue which highlights the state's potential for the tourism industry. According to Tennessee Department of Tourist Development's (TDTD) 2019 annual report, tourism industry in Tennessee supports about 190,000 jobs in the state, generates a payroll of approximately $5 billion with over $22 billion in travel expenditures, and a tax revenue of about $2 billion. Analyses have shown that Tennessee (domestic travel) is the largest origin market for tourists followed by neighboring states Alabama, North Carolina, Georgia, and Kentucky (TDTD, 2018). The transportation system and services facilitating travel from outside as well as within state is necessary to promote tourism in Tennessee.

Research has shown that availability of transportation services in recreational areas determines trip characteristics of tourists and the recreational activities they engage in (Anderson et al., 2011). For example, the availability of bicycle facilities and infrastructure encourages tourists to use bicycles for transportation and recreational purposes. According to the recent data, the five major cities in Tennessee are among the 250 most congested in the US with Nashville ranked at 54, Cleveland at 138, Memphis at 144, Chattanooga at 166, and Knoxville at 198 (*INRIX 2021 Global Traffic Scorecard*, 2021). Therefore, an effective transportation system that offers alternative services and contributes towards reduction of congestion in major cities and destinations is necessary. Developing policies that encourage the use of multimodal transportation systems and enhance tourists' experience by reducing traffic congestion on major tourist routes and destinations is essential for tourism.

States with large tourism industries have invested considerably in transportation systems and services. Similarly, Tennessee needs to develop and maintain a robust and sustainable transportation system that can cater to the needs of the fast-growing tourism industry. Many recreational destinations in the state see a seasonal influx of tourists that exceeds the current capacity of transportation services. Therefore, development of multimodal inter-city and intra-city transportation services accompanied by effective operational policies is necessary to promote the quality of tourism travel and establish the state as a primary attraction among tourists.

This study investigates measures taken by states across the country to establish an effective transportation system that supports tourism. An assessment of the current state of transportation systems in the state using surveys and analysis of long-distance travel is undertaken to present Tennessee Department of Transportation (TDOT) with planning policies and recommendations to establish a sustainable transportation system that can serve the growing needs of tourists traveling to the state.

1.2 Project objectives

The overarching goal of the research project is to develop planning and policy guidelines for sustainable transportation systems and services in promoting the tourism industry in Tennessee. The specific objectives of the project are:

1. Undertake a comprehensive review of the literature on transportation planning adopted by other states in the US and elsewhere.
2. Identify the current state of transportation systems and services available to tourists, their deficiencies, and potential measures for their improvement.
3. Identify key destinations and corridors across the state that are primarily used by tourists or long-distance travelers.
4. Develop policies and guidelines for a sustainable transportation system capable of promoting the tourism industry.

1.3 Methodological approach

The methodological approach undertaken by the research team can be summarized under six steps as follows. A detailed description of the methodology is presented in Chapter 3.

1. Review of the literature to gather an understanding of state-of-the-art practices in terms of planning for tourism related sustainable transportation systems and services.
2. Survey of state Departments of Transportation (DOTs) and State Tourism Offices (STOs) to understand state specific tourism related travel demand modeling practices, tourism data sources, data analysis methods, tourism inclusive project selection practices, consideration of sustainable transportation for tourism, and the collaboration between diverse tourism stakeholders.
3. Analysis of tourism trip characteristics, which is fundamental to long-distance passenger travel demand models, using online survey of travelers.
4. Analysis of current and forecasted tourist travel patterns using the national long-distance travel demand model and scenario analysis.
5. Survey of local tourism agencies on the present state of tourism transportation system and services in their jurisdiction, current deficiencies, and preferred improvements.
6. Make policy level recommendations based on findings.

1.4 Report organization

The rest of the report is organized as follows. Chapter 2 includes a brief review of the literature encompassing various aspects of transportation systems and services associated with tourism. This includes economic impacts of tourism, methodological approaches used for data collection and analysis of long-distance trips. Chapter 3 presents a detailed description of the stepwise methodology applied in the current research project. The findings from applied methods are included in Chapter 4. Chapter 5 presents a detailed conclusion of the research project along with policy recommendations.

Chapter 2 Literature Review

An extensive review and synthesis of published research and pilot projects related to sustainable tourism transportation was undertaken to get an understanding of state-of-the-art practices across agencies. Our review included all aspects of planning and development of sustainable transportation systems and services for tourism. The literature is summarized as follows.

2.1 Tourism transportation in the U.S.

Tourism travel is defined as the temporary movement of people to various destinations outside their normal travel patterns (e.g., commuting to work or going shopping for groceries) (Pincus et al., 1999). Tourism specifically focuses on travel comprising of a night away from home or a day trip which is 50 or more miles one way, with the basic unit of measurement is a "person-day" (Pincus et al., 1999). This definition allows transportation planners to separate tourism trips from commuter trips and assess their economic impacts on communities. Tourism has positive impacts on a local community but also has negative impacts. The positive or negative impacts of tourism can be categorized into four main types: economic, social, cultural, and environmental (Holden, 2016). Unplanned growth of tourism industries and related infrastructures and services can lead to a variety of detrimental impacts on communities, economic bases, and natural resources. Sustainable tourism includes planned transportation systems and services that can be used to control and manage the travel demand for tourist destinations (i.e., right number of tourists, at the right destination of choice, at the right times) which could balance the sustainability of destination ecology, economic interest of local communities and transportation systems capacity. Sustainable transportation systems ensure a viable relationship between local population and tourists by minimizing the negative impacts of tourism-related transportation.

According to the National Advisory Committee on Travel and Tourism Infrastructure (NACTTI), the tourism industry accounts for 2.7% of GDP and seventh-largest employment sector in the U.S. (NACTTI, 2016). In 2017, the U.S travel and tourism industry generated over $1.6 trillion in economic output while supporting 7.8 million American jobs and one in eighteen U.S. jobs, directly and indirectly, relied on the travel and tourism industry (SelectUSA, 2020). Tennessee is among the fastest-growing travel destinations in the U.S. for international tourists. In 2019, Tennessee tourism hit a record-high $23.27 billion in annual economic impact (*The Soundtrack of America: Made in Tennessee (FY 2019 Annual Report)*, 2018). Tourism supported 195,000 jobs and produced $1.92 billion in state and local sales tax revenue in 2019. Travel to Tennessee topped 126.18 million person stays in 2019, up 5.7 percent from the previous year. In 2019, 92 counties in the state saw an increase in domestic travel spending.

2.2 Long Distance Travel Demand Models for Tourism trips

A significant portion of long-distance trips are recreational trips. Previous studies defined "long-distance" trips based on the travel distance (e.g., longer than 50 miles) and travel times (e.g., greater than 40 minutes one way travel time) (Bierce & Kurth, 2014). Several studies defined long-distance trips that were greater than 50 miles (Bierce & Kurth, 2014; Erhardt et al., 2007; Rohr et al., 2013) and few other studies considered trips longer than 100 miles as long-distance trips (Frei et al., 2010; Frick & Grimm, 2014; Kuhnimhof et al., 2014). Though long-distance tourism trips represent only 1% of the total trips, they share 15% of the total vehicle miles traveled (VMT) in

the U.S. (Schiffer, 2012). Long-distance tourism trips have not been an integral part of the state or regional travel demand models in the US for many years because of the lack of modeling data. In the last few years, several initiatives and new data sources have enabled the inclusion of long-distance trips in travel demand modeling (e.g., (Davis et al., 2018; Llorca et al., 2018; Yang et al., 2019)).

Erhardt et al. (2007) developed a long-distance travel model as a part of the Ohio statewide travel demand model (Erhardt et al., 2007). In this study, the authors used the Long-Distance Travel (LDT) survey to collect information on all trips greater than 40 mi, which were not regular work commute trips. The LDT model was developed using 3,660 traffic analysis zones (TAZs) in Ohio and a ring of 588 TAZs outside Ohio. Households with more automobiles and higher incomes were more likely to make long-distance trips due to a higher level of mobility and a higher income level to absorb cost. The study also found that hotel employment was a strong indicator of long-distance travel as travelers stay near tourist attractions and business districts. Rohr et al. (2013) developed an LDT model for Great Britain. This study reported a positive relationship between car ownership and long-distance travel. Similar to the Ohio LDT model, this study also found that income had a strong positive effect on long-distance travel. Men were more likely to make long-distance recreational trips compared to women, whereas families with children were less likely to make long-distance trips.

Another study integrated a national long-distance trip model to the statewide travel demand model in Tennessee (Bernardin Jr et al., 2017). The Federal Highway Administration's new national long-distance passenger travel model (rJourney) was used in the Tennessee statewide travel demand model and calibrated the model using cell phone data. In the study, the researchers used long-distance origin-destination (O-D) data derived from cell phone data to model the statewide long-distance trips. Another study in California used long-distance tour data collected through statewide household travel surveys to explore non-commute long-distance trips' behavioral factors (Davis et al., 2018). This study also used social media data (i.e., Foursquare) to describe destination characteristics and their significance in explaining long-distance tour behavior. Foursquare data was used to identify the participants' long-distance by activity type. Long-distance trips were often chaining of trips with different purposes. Path analysis of long-distance tours found that high-income households were likely to travel by air and often combined work trips and leisure trips. On the other hand, low-income households were most likely to rely on vehicular travel. The miles driven by car was positively associated with the number of employed household members. Larger households were less likely to make long-distance tours with many miles driven and households not living in single-family homes were less likely to drive far. Households with lower income, with lower number of cars, and living in city centers were more likely to make tours using public transportation services.

Similarly, a long-distance travel demand model was developed for the province of Ontario, Canada using trip survey data, location-based big data, and trip planning services (Llorca et al., 2018). According to the Travel Survey for Residents in Canada, long-distance trips were defined as non-recurrent overnight trips and day trips longer than 40 km. Foursquare and Rome2rio data were combined with trip survey data in developing a microscopic discrete choice long-distance travel demand model. Combining these two data provided a comprehensive view of the long-distance travel characteristics. Foursquare data was statistically significant on the number of check-ins at destinations, especially for leisure trips, and improved the goodness-of-fit compared

with models that only used population and employment. Day trips were more likely to have a closer destination, while long tours were mostly overnight trips. The chances of choosing air travel compared to personal vehicle increased with the increase in trip distance and an overnight trip. Similar to other studies, this study also found that higher income groups had a lower probability of selecting bus and rail.

2.3 Current Tourism Development Strategies and Guidelines

The National Cooperative Highway Research Program (NCHRP) Report 419: *Tourism Travel and Transportation System Development* surveyed state travel/tourism offices and DOTs to determine their policies and institutional practices supporting tourism growth (Frechtling et al., 1998). Survey findings indicated that interagency coordination was key to effective planning and implementing transportation projects that support tourism. Usually, state DOT and state travel offices collect different types of tourist data, which can be shared to facilitate more integrated decisions on tourism-related transportation projects in an informed way. This study identified eleven principles that emphasized the need for collaboration between different public and private tourism stakeholders, involvement of the private sector, and performance measures for tourism transportation services. In addition, this study proposed guidelines to be considered in the development of integrated planning and project development (Frechtling et al., 1998).

Recently, several state DOTs have developed plans to integrate tourism into transportation planning. In 2015, the California Department of Transportation developed the Interregional Transportation Strategic Plan that includes two criteria related to tourism in individual transportation project funding decision-making. The first criterion focused on the project's impact on improving corridor access to/from major generators of economic activity (e.g., passenger and/or freight gateways, business centers) and tourism destinations. The second criterion focused on the possible reduction in travel time to and from freight gateways, centers of significant economic activity, jobs, or tourism destinations. Similarly, Travel Michigan developed a strategic tourism plan for the year 2012 to 2017 by analyzing the deficiencies in the tourism industry and potential ways to overcome the shortcomings. Informal and formal collaboration and cooperation between public and private entities were vital for the success of both individual tourism businesses and the entire tourism industry in Michigan (Nicholls, 2012). To improve the quality, connectivity, and diversity of tourist transportation service options throughout Michigan, the strategic tourism plan outlined collaboration plans with Michigan DOT. The study documented strategies for enhancing the visitor's in-state travel experience by working with Michigan DOT to standardize and improve the Welcome Center experience and keep selected rest areas open year-round. The study also outlined plans to work with other appropriate authorities to establish tourism information kiosks in high visitor traffic areas (e.g., welcome centers, airports, train stations, convention centers).

2.4 Recreational travel intentions

Compared to the previous year, there was a 59% and 70% decrease in domestic and international air travel respectively in 2020 because of the COVID-19 pandemic (Heeb, 2021). As of Summer 2022, various strains of the virus are still circulating, and the travel industry should remain prepared for future outbreaks. Identifying quick economic recovery measures in advance can be helpful in this regard. Understanding the public's opinions, psychological constructs, and travel

intentions can be beneficial to this. Therefore, research was undertaken, as a part of the project, to investigate the travel intentions of tourists.

Travel intentions can be assessed using the Theory of Planned Behavior (TPB) that is based on Structural Equation Modeling (SEM) (Ajzen, 1991). Applying SEM requires survey data with attitudinal questions administered to tourists (in case of this study, those who traveled to Tennessee in the past). Furthermore, TPB can be improved with other analysis techniques such as Necessary Condition Analysis (NCA) (Dul, 2016). Unlike commonly employed regression techniques that test whether a predictor is sufficient to affect the outcome variable, NCA can test whether the predictors are necessary to manifest the outcome thus addressing questions like, "*Is a psychological construct, which is an antecedent to recreational travel intention during the pandemic, both sufficient and necessary to affect it? If yes, what is the minimum condition needed for the psychological construct to manifest travel intentions?*" The upcoming subsections present a brief review of the literature on TPB and NCA.

2.4.1 Theory of Planned Behavior

Prediction of behavior as an outcome of intentions is based on the TPB (Ajzen, 1991**).** TPB asserts that behavioral intentions, defined as factors that motivate certain behavior without necessarily the behavior being performed**,** are affected by attitude, subjective norm, and perceived behavioral control. Attitude refers to an individual's evaluation of the behavior in question. Subjective norm is an individual's approval or disapproval of people's views and opinions regarding the behavior. Perceived behavioral control is people's perceptions of their ability to perform the behavior. Favorable attitude, subjective norm, and greater perceived behavioral control usually strengthen behavioral intentions (Ajzen, 1991**).** More recent studies have provided substantial evidence of this (Kim & Stepchenkova, 2020; Pooley & O'Connor, 2000).

Extension of traditional TPB is necessary when studying human decisions and behavior in different settings. The Extended TPB (ETPB) incorporates various latent variables depending on the research context to gain meaningful behavioral insights. Some of the variables that have been included in ETPB and relevant to this study are *socio-demographic attributes, past travel behavior, public trust, anxiety, self-composure, travel concern, perceived knowledge, and perceived benefits.*

2.4.2 Necessary Condition Analysis

The literature on NCA is limited since it is relatively new. The framework was first introduced to identify the necessity of predictors in achieving favorable outcomes in organizational settings (Dul, 2016). NCA is designed to complement the traditional sufficiency logic (i.e., a predictor is sufficient to affect the outcome) imposed by regression techniques by applying the necessity logic (i.e., the mere presence of a predictor might not be sufficient to affect the outcome, but a certain level of the predictor might be necessary). Its application on SEM was demonstrated using the traditional technology acceptance model where technology use is predicted by the various latent psychological constructs (Richter et al., 2020). More recently, it was used to investigate holiday intentions during the COVID-19 pandemic (Pappas, 2021). In their study, researchers reported perceived travel, destination, and hospitality risks were necessary for predicting travel intentions.

Chapter 3 Methodology

Following review of the literature, the study followed a stepwise methodology to accomplish the project objectives. These steps are detailed in the upcoming sections and briefly introduced as follows.

1. Survey of state DOTs and STOs on tourism related planning and managing of transportation projects and systems, and its analysis using clustering.
2. Analysis of tourists' trip characteristics and travel intentions using responses collected from an online survey.
3. Use of national long-distance travel model and scenario analysis to ascertain potential impacts of various initiatives on tourism.
4. Identification of popular tourist attractions and an assessment of accessibility to them.
5. Investigation of available transportation services, their deficiencies and measures for improvement based on survey administered on local tourism agencies.
6. Policy implications based on findings from applied methods and analyses.

3.1 Survey of state DOTs and STOs

A survey of state DOTs and STOs across the country was undertaken to understand state specific travel demand modeling practices, sources of tourism data and methods used in its analysis, project selection practices, and collaboration between agencies. The survey was conducted online using Qualtrics between June-July 2021. The single survey questionnaire was developed for both state DOTs and STOs. Based on the selection of the respondent (whether they work for a state transportation department or a tourism agency), they were directed to questions relevant to them. On average, the survey took about 10 minutes to complete.

In total, 19 DOTs and 20 STOs responded to the survey. Only 33 responses were complete and used in our analysis. The responses were analyzed to get a distinct idea of practices followed across the country using the *k*-means clustering method. Summary of responses to key questions in the survey is presented and briefly discussed in Chapter 4: Results and Discussion of the report. The analysis framework used for clustering is as follows. Additional details on the framework, and its data is presented in Appendix A.

3.1.1 Analysis of survey responses using clustering technique

The overall analysis framework used to analyze the survey responses is presented and outlined in Figure 3-1. In steps 1 and 2, a search engine database was created for tourism travel-related keywords. Based on the findings of past studies, five major aspects of tourism travel (i.e., lodging, dining, tour, traffic, and recreation) were considered in this study to extract the search engine data. These five categories represent travel demand and capture the supply side of the tourism industry. Twenty-five keywords were selected for the search engine data collection. Google search engine data was considered in this study. Once the keywords associated with tourism travel were selected, they were manually checked using Google Trends website to ensure their availability. Google presents the keyword data relative to the highest point on the chart for the given spatial and temporal extent (GoogleTrends, 2021). They provide the value of a keyword using a scale of 0 to 100. Next, several variables related to tourism travel and its impact on the local economy, such as travel spending by domestic and international visitors, jobs created by

tourism travel, and tax collected from the travel industry, were selected to determine tourism-related travel characteristics of the states.

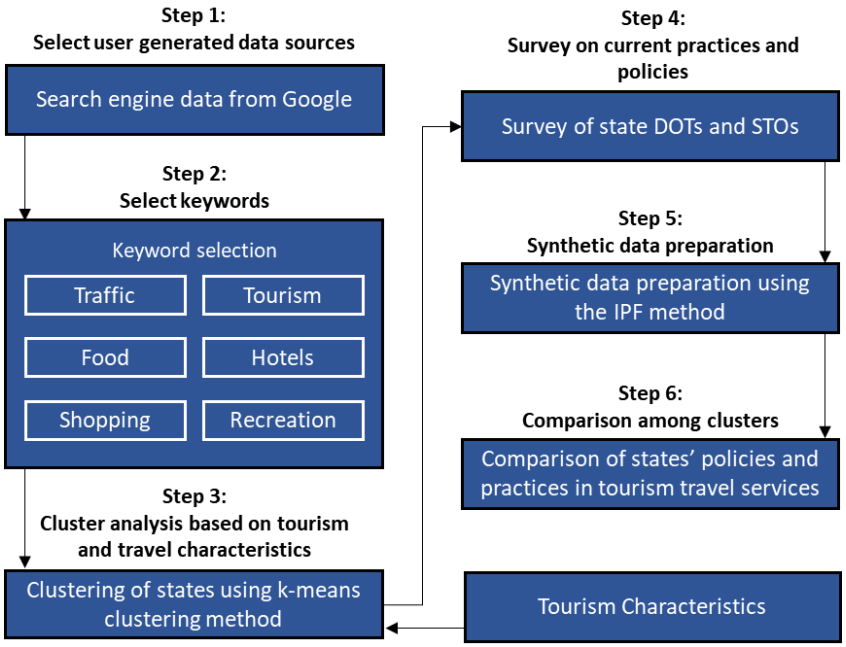


Figure 3-1 Framework used to analyze survey responses

Tourism travel-related data were collected and processed for the clustering analysis in step 3. Several variables related to tourism travel and its impact on the local economy, such as travel spending by domestic and international visitors, jobs created by tourism travel, and tax collected from the travel industry, were selected to determine tourism-related travel characteristics of the states. Search engine data related to travel and tourism mentioned in steps 1 and 2 were collected and used as a proxy variable to include state-wise tourism volume and travel pattern in the clustering process. Then, fifty U.S. states were clustered based on their tourism and travel characteristics. For the classification technique, the *k*-means clustering method was used which is one of the most popular unsupervised classification algorithms used in classification problems (Mather & Tso, 2016). The clustering method divided the states into clusters based on uniform travel and tourism characteristics.

Step 5 of the framework was synthetic data preparation to generate survey data for states that did not respond to the survey based on recorded responses. Iterative Proportional Fitting (IPF), which was introduced by Deming and Stephan (1940), is an efficient and popular method for synthetic population data generation from sample data (Tibshirani et al., 2001). Once the clustering process was completed, the IPF algorithm was used to generate synthetic survey data for all states within each cluster using the recorded survey responses. For this study, only questions related to the collaboration manner, performance measures, the role of the private sector, data collection, and forecasting method were synthesized. As the characteristics of the states within each cluster were homogeneous, the synthetic data for each category should represent tourism characteristics reasonably well.

3.2 Analysis of tourist trip characteristics

A second online survey was administered to people ages 18 and above who had travelled to a recreational destination in Tennessee. The goal of this survey was to gather information on trip characteristics of tourists which is a critical component of long-distance passenger travel demand models (Outwater et al., 2015). This survey was administered on an online panel from Centiment (*Centiment*, 2021) using Qualtrics between May-June 2021. The survey was comprised of questions on socio-demographics, household characteristics, trip characteristics, and recreational travel attitude in relation to the COVID-19 pandemic and took about 13 minutes to complete. A quota sampling approach was followed to ensure the validity of responses. Age and gender of the respondents was used as quota variables. The panel generated over 2,000 participants of which complete responses were obtained from 1,259 individuals.

The responses collected from the survey were analyzed in two steps which included i) descriptive statistics of trip characteristics, and ii) investigation of variables predicting travel intention during the COVID-19 pandemic.

3.2.1 Summary of trip characteristics

In the first step, descriptive statistics for major variables associated with socio-demographics, household characteristics, trip characteristics, mode of travel, etc. were obtained to get a better understanding of tourists and trip characteristics. While responses were also collected on travel attitudes, particularly, considering the COVID-19 pandemic, they were utilized to investigate travel intentions.

3.2.2 Antecedents to recreational travel intentions

As mentioned, in the second step, a research study was also undertaken to analyze responses collected on recreational travel attitude in relation to the COVID-19 pandemic. The goal of the study was to identify policy interventions that could be helpful in encouraging tourists to travel during and after the pandemic. Our analysis used SEM based ETPB, and NCA to investigate predictors of travel intentions and the necessary conditions, respectively.

3.2.2.1 Structural Equation Modeling

Psychological constructs represent an individual's beliefs that affect their behavior. Unlike observable variables they cannot be directly measured. They are derived from indicators in a survey. The indicators ask respondents to rate certain attributes on a scale. These attributes are designed to represent the beliefs and values of the respondents. Indicators are then used to extract underlying latent psychological constructs based on correlation within one another using factor analysis. SEM utilizes these latent constructs to investigate causal relationships using hypotheses derived based on theoretical reasoning, logic, and prior research. SEM comprises two components, i) structural equations and ii) measurement equations. Structural equations define the relationship between the latent constructs and exogenous explanatory variables. The measurement equations establish the relationship between indicators and the latent constructs.

The SEM model proposed for this study is shown in Figure 3-2 which is a representation of the hypotheses used to guide our analyses. Moderating effects of public trust and subjective norms were also introduced in our analysis. These hypotheses and results are presented in detail in Appendix B. It is worth mentioning that the moderation effects in our SEM were introduced using the indicator product approach (Steinmetz et al., 2011).

3.2.2.2 Necessary Condition Analysis

NCA is based on the premise of necessity logic that states certain observed outcomes manifest only when a certain value of the predictor is present. NCA uses ceiling lines that are drawn either using non-decreasing piecewise linear functions called Ceiling Envelopment or continuous function Ceiling Regression (Dul, 2016) to find these values. These lines separate the smallest rectangle that can enclose all the observations plotted in the Cartesian coordinate system (outcome on the *y*-axis, predictor on the *x*-axis) into two zones, scope (lower zone) that encapsulates all the observations and ceiling (upper zone) above the observations. Using effect size, *d* the necessity of a variable in manifesting the outcome can then be evaluated. The effect size is always positive and less than 1 and its Interpretation depends on the context (Dul, 2016). For the study, we considered an effect size, $d \geq 0.1$ as an indication of the necessary condition since $d < 0.1$ is considered a small effect (Dul et al., 2020). NCA also facilitates calculation of bottlenecks which determines the minimum "level" of the predictor variable necessary to manifest a certain "level" of outcome in the response variable.

There are several ceiling functions. In this study, we employ the CR-Free Disposal Hull (CR-FDH) ceiling function due to the continuous nature of the composite latent variable scores obtained from SEM (Dul et al., 2020). CR-FDH function is drawn by applying ordinary least squares regression on the leftmost edges of the CE-FDH function.

For our investigation, first, SEM analysis was undertaken and the statistically significant exogenous predictors (socio-demographics and travel behavior) of latent constructs were then identified. Then the relationship between the latent factors was investigated using the developed hypotheses. NCA was then used to investigate the necessity of the latent predictors in manifesting their respective outcomes. All predictor latent factors regardless of their significance in SEM were included in NCA. This was done because certain variables insignificant in SEM could still be significant in NCA (Richter et al., 2020).

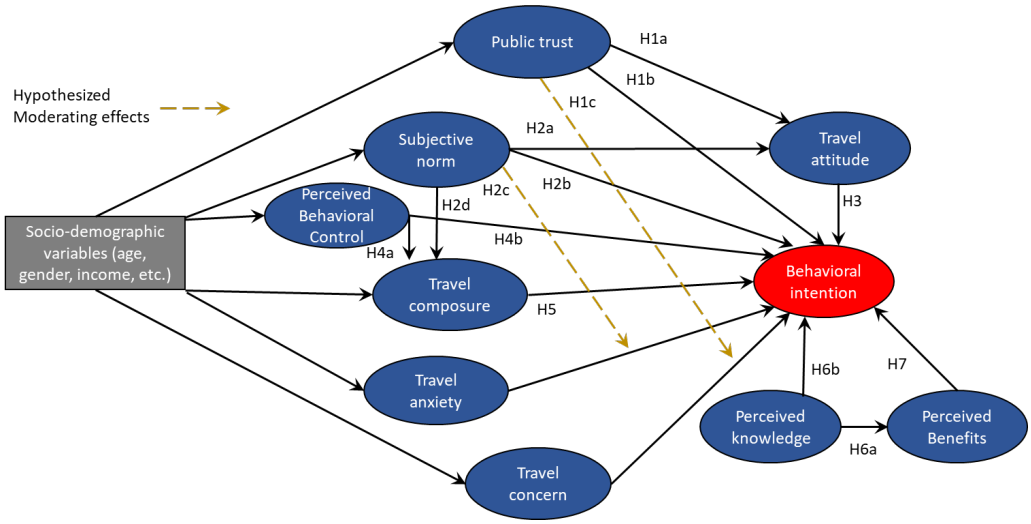


Figure 3-2 Theoretical model used in SEM analysis

3.3 Analysis using national long-distance travel model

The objective of this task was to apply the national long-distance model to identify and forecast tourism travel characteristics in Tennessee using scenario analysis. The national long-distance model is a tour-based simulation model for long distance travel behavior and patterns. It is implemented through a software platform known as rJourney (Outwater et al., 2015). The passenger travel demand model operates as follows. First, the national long-distance model estimates tour generation, scheduling, duration, and party-size models by purpose. Next, it incorporates mode and destination choice models for different purposes, which include leisure and vacation, visits to friends or relatives, personal business, commuting, and employer's business. Four modes can be modeled in accomplishing the estimated trips by purpose, which are personal cars, intercity bus, intercity rail, and commercial air travel. The rJourney tool allows the evaluation of different policy scenarios including transportation system improvement, fare or service changes for various modes including highway, commercial air travel, intercity bus, and intercity rail.

3.3.1 Scenario development

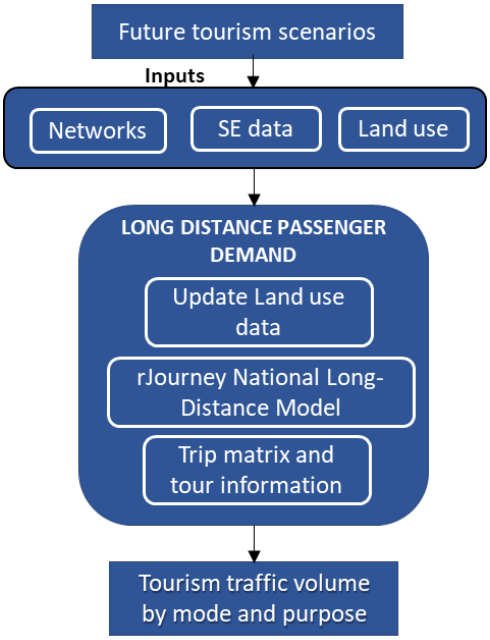


Figure 3-3 Long distance travel simulation framework

The steps followed for scenario analysis in this study is presented in Figure 3-3. The national long-distance travel demand model adopts National Use Model Area (NUMA) based zone system. NUMA-level zone system is a composite representation of counties and Census Bureau Public Use Microdata Areas (PUMA) across the U.S. (Outwater et al., 2015). Adopting different zone systems increase computational requirements and complexity in the data preparation process. As the rJourney tool can model a maximum of 4,700 TAZs, the default NUMA zone system was retained for the long-distance travel modeling in Tennessee. In addition, default synthetic population data which includes around 115 million households, was used for the long-distance model.

For the long-distance modeling, the rJourney simulation tool utilizes national land use data generated using 2010 census data. To update the model for 2019, Census Tract (CT) level land use data was collected from Census Bureau, US National Park Service, and National Center for Education website. Then, the CT level data was aggregated to the NUMA level using ArcGIS Pro software. Table 3-1 presents the summary statistics of the land use variables used in the long-distance travel demand model.

Table 3-1 Descriptive statistics of land use variables (N=4,566)

Variable	Min	Max	Mean	Std. Dev
The land area in public parks (square miles)	0	62,940.05	150.54	1310.96
The number of households living	0	883,434.00	26,908.54	28,365.71
The number of university students enrolled	0	17,0061.00	4,469.98	11,054.64
The total number of jobs in the zone	1	938,014.00	28,193.98	41,616.61
The number of agricultural jobs in the zone	0	7,710.00	248.56	413.20
The number of mining jobs in the zone	0	11,210	130.02	404.24
The number of utility jobs in the zone	0	5,913	202.46	232.35
The number of construction jobs in the zone	0	76,465	1,575.56	2,018.38
The number of manufacturing jobs in the zone	0	31,245	2,187.65	2,469.25
The number of wholesale trade jobs in the zone	0	28,270	540.64	727.39
The number of retail trade jobs	0	53,458	1,314.02	1,559.76
The number of transportation services jobs	0	59,856	918.80	1,346.47
The number of information services jobs	0	13,122	332.87	557.90
The number of financial services jobs	0	24,572	612.85	1,077.72
The number of real estate service jobs	0	19,163	274.63	454.37
The number of professional services jobs	0	40,753	1,162.99	1,969.62
The number of managerial jobs	0	469	18.86	38.31
The number of administrative jobs	0	32,587	615.26	848.28
The number of education jobs	0	21,350	671.13	848.68
The number of medical jobs	0	37,000	805.58	1,067.84
The number of entertainment jobs	0	10,657	225.74	379.44
The number of accommodation jobs	0	44,921	654.43	1,081.57
The number of other service category jobs	0	50,949	996.68	1,789.32
The number of public administration jobs	0	22,553	799.63	1,046.15
Bus stations within 40 miles	0	130	14.02	21.63
Rail Stations within 50 miles	0	40.83	4.83	7.03
Distance from zone centroid to nearest rail station	0	48	12.11	12.23
Airports within 100 miles	0	11.12	3.54	2.24

3.3.2 Model implementation

The rJourney software tool allows several system parameters to manage the simulation process in terms of runtime and computational power. The simulation control parameters and their values used in this study are listed in Table 3-2. For the simulation process, the household sampling rate was set to 100 (i.e., 1% of the households were sampled with the expansion factor of 100). The long-distance travels are defined based on the distance between the TAZs. Past studies used different distance thresholds in defining the long-distance trip. The most common

trip distance threshold used in past studies is 100 miles in one direction of travel (Bierce & Kurth, 2014). In this research, the long-distance travel cutoff value was set to 100 miles.

Table 3-2 Parameter values used in scenario analysis

Parameters	Values
Household Sampling Rate	100
Months Simulated	All
Each Day of Month Separately?	Yes
Use Probabilities in Trip Matrix?	No
Expansion Factors	100
HH Records (Million)	1.1
Long Distance Travel cutoff value (miles)	100

The rJourney can be used to study system-wide changes (e.g., impact of higher travel cost) and their impacts on long distance travel distribution. System-wide changes that can be modeled are household income, auto travel cost, auto travel time, air fare, and rail travel time. Four future scenarios based on transit accessibility improvement, household income, auto travel cost, and auto travel time were developed to investigate associated impacts on long-distance travel demand in Tennessee.

3.3.3 Scenario analysis

Long-distance travel pattern in the state for base case scenario is presented in Figure 3-4 with the updated 2019 land use data. As evident from the figure, the highest number of long-distance trips associated to Nashville, Kingsport, and Knoxville. After modeling base scenario (no change scenario), the long-distance travel demand models were simulated for four future scenarios which are summarized in Table 3-3. These four future scenarios were developed to assess the effect of relevant policy sensitive variables on long-distance travel patterns in Tennessee. The result from the sensitivity analysis and key findings are discussed in the following subsections.

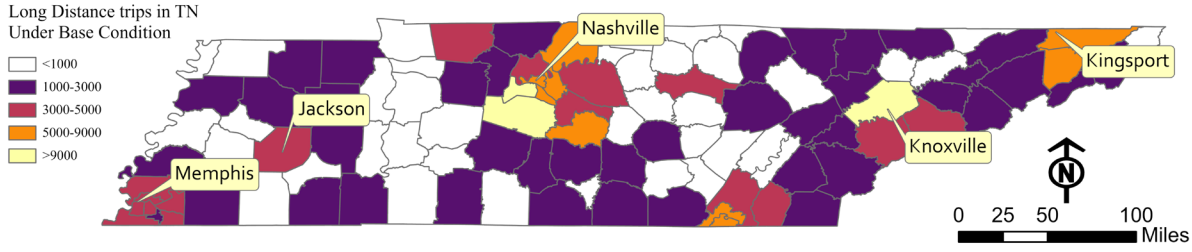


Figure 3-4 Long distance trips per year in Tennessee for base scenario

Table 3-3 Summary of the proposed scenarios

Scenarios	Description	Properties	Min Change	Max Change
1	Transit access improvement	# of bus stops	30%	50%
		# of rail station	15%	25%
		# of airport	20%	30%
2	Air fare policy	Air fare	-30%	-50%
3	Lower congestion along major tourist routes	Auto travel time	-25%	-50%
4	Increase in household Income	Household income	15%	30%

3.3.3.1 Scenario 1: Impacts of transit access improvement

High-quality and easily accessible transit services are critical for encouraging people to switch from personal vehicles to public transportation (Liu et al., 2019). Several states developed tourism strategic plans by focusing on transportation services as a key element in overcoming mobility challenges and promoting tourism. According to Virginia Tourism Corporation, increased air access, rail, and mass transit for strategic locations can promote tourism travels (Virginia Tourism Corportation, 2013). In this scenario, impact of higher transit access to major tourist destination in Tennessee was assessed in terms of increase in long-distance trip volume. For this purpose, the number of bus stops within 40 miles of the NUMA centroid was increased by 30% to 50%. To estimate the impact of increased rail access, the number of rail stations within 50 miles of the NUMA centroid was increased by 15% to 25%. Similarly, the number of airports within 100 miles radius of NUMA centroid was increased by 20% to 30% to estimate impact of increased accessibility to air travel. This transit access growth forecast is based on the proportional and modest expansion of the transit ridership for the next 20 years in the state (Tennessee Department of Transportation, 2016).

3.3.3.2 Scenario 2: Impacts of air fare policy on tourism travel

Past studies reported that reduced transit fare targeted to specific groups of people resulted in transit ridership increase (Darling et al., 2021). Furthermore, the survey (conducted in this study) among tourism stakeholders revealed that reduced fares for the tourism transit services can increase tourist volume and reduce auto dependency among visitors. It has been reported that doubling the air fare would decrease the long-distance trips by 8% and increase modal shift from air to auto by 3.2% (Outwater et al., 2015). In this scenario, air fares will be reduced by 25 to 50% to estimate the impacts of reduced air fare policy on tourism trips.

3.3.3.3 Scenario 3: Impacts of lower congestion along major tourist routes

Several tourism agencies mentioned traffic congestion as one of the limiting factors of tourism growth (Gonzalez-Rivera, 2018; Virginia Tourism Corportation, 2013). According to Virginia Tourism Corporation, traffic congestion negatively impacted tourist volume and reduced cross-visitation trips among tourist destinations (Virginia Tourism Corportation, 2013). Alleviating traffic congestion can decrease the time people spend traveling, increase time spent at tourist attractions and encourage people to visit additional tourist attractions. In this scenario, we simulate the traffic congestion reduction by decreasing the auto and bus travel time for major tourist zones in Tennessee. The auto travel time is reduced by 25 to 50% to estimate associated improvement in tourism trips, based on past findings (Outwater et al., 2015).

3.3.3.4 Scenario 4: Impacts of increase on household Income

Previous study suggests a direct relationship between the frequency of recreational long-distance and higher household incomes (Outwater et al., 2015). Household incomes also affect mode share for long-distance trips as people with higher household incomes tend to use personal vehicles more frequently than public transport. In this scenario, the household income was increased by 15 to 30% (Outwater et al., 2015).

3.4 Analysis of popular attractions

In the fourth step, an analysis of popular attractions in the state was undertaken to gather a synopsis of accessibility to tourist destinations. A list of 50 most popular attractions was compiled based on their popularity in Google reviews (see Appendix C for the list). These attractions were shortlisted from destinations included in the 2022 Tennessee Vacation Guide (*The Soundtrack of America: Made in Tennessee (2022 Vacation Guide)*, 2022). Finally, only those with at least 250 reviews (4.5 stars and above) were enlisted.

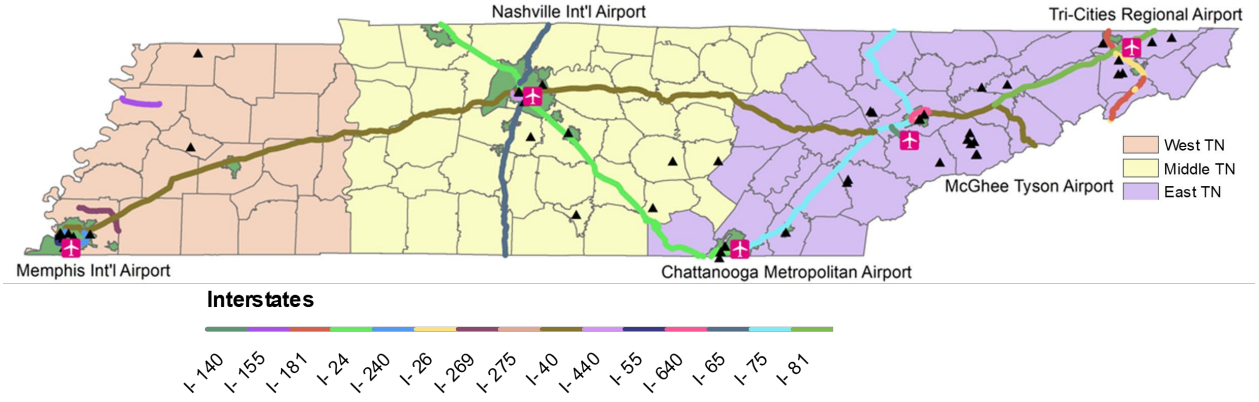


Figure 3-5 Popular attractions in Tennessee

These destinations were analyzed in two steps. In the first step, access to these destinations was evaluated based on travel time and distance from the nearest i) Urbanized Areas (UAs), ii) primary service commercial airport, iii) interstate, or transit stop. Figure 3-5 shows the locations of the destinations along with the UAs, the five primary commercial airports, and statewide interstate system. In the second step, trips made to major destinations were analyzed using INRIX Trip Analytics. Since it was impractical and cumbersome to analyze trips made to all these destinations five cities: Memphis, Nashville, Chattanooga, Knoxville, and Gatlinburg were considered for analysis as they are home to many several attractions. Trips made to these locations through major highways were used to extract origins, destinations, and number of trips. The primary goal of this task was to identify major origin markets from where people traveled.

In addition, the national long distance passenger travel demand model was used to identify the 10 Origin-Destination (O-D) pairs within the state with the most trips. To get an idea of current traffic flow conditions on the route serving these O-D pairs, values of Travel Time Index (TTI) for weekdays and weekends were calculated using data from INRIX Trip Analytics.

3.4.1 Access to destinations

3.4.1.1 Access from nearest urbanized area

According to the urban-rural classification presented by the Census Bureau, UAs are those with a population greater than 50,000 people. According to the 2020 census data, there are 15 UAs in Tennessee (*2020 PL 94-171 Redistricting Data Summary File*, 2022). These cities are outlined in Table 3-4. As an indicator of access, the travel distance and travel time between an attraction and the nearest UA was derived from Google Map searches. Of all available routes, the route with the shortest travel time during PM peak was considered as the measure of access.

Table 3-4 Urbanized Areas in Tennessee based on the 2020 census

City	Population	City	Population	City	Population
Nashville	715,884	Murfreesboro	152,769	Bartlett	57,786
Memphis	633,104	Franklin	83,454	Kingsport	55,442
Knoxville	190,740	Johnson City	71,046	Smyrna	53,070
Chattanooga	181,099	Jackson	68,205	Collierville	51,324
Clarksville	166,722	Hendersonville	61,753	Spring Hill	50,005

3.4.1.2 Access from nearest primary service commercial airport

Access from nearest primary service commercial airports to the tourist destinations was also determined using travel distance and travel time. Primary service commercial airports are publicly owned airports that have more than 10,000 passengers boarding each year. These airports serve as major hubs for passengers flying to and from destinations. There are five such airports in Tennessee: Memphis International airport, Nashville International Airport, McGhee Tyson Airport, Chattanooga Metropolitan Airport, and Tri-Cities Regional Airport. The distance and travel time from the nearest airport to the attractions when using the fastest route during the PM peak hours was obtained using Google Maps (*Google Maps*, 2021).

3.4.1.3 Access from nearest interstate and transit stops

Figure 3-5 suggests that the identified attractions are located within and outside the UAs. To ascertain access to the destinations, two metrics were used. For the destination inside UAs, the travel distance and travel time from nearest interstate exits and transit stops was determined. Access to destinations outside UAs was determined based only on the distance from nearest interstate exit since they are not accessible using transit services.

The travel time and distance from transit stops to the destinations was determined based on either walking or driving depending on the distance between the stop and the destination. An assumption was made that passengers traveling more than 0.5 miles from transit stops would refrain from walking and use cars or other modes (usually micro-mobility options) for their travel (Nabors et al., 2008). Nearest transit stops to the attractions within Memphis, Nashville, Chattanooga, and Knoxville were determined using stops detailed in General Transit Feed Specification (GTFS) data. For certain cities, Pigeon Forge, Gatlinburg, and Kingsport, maps posted online by respective transit agencies were used to identify the stops. These stops were then manually located on Google Maps of further analysis.

3.4.2 Analysis of trips for identification of origin markets

In the second step of analyzing tourist attractions, an analysis of origin and destinations was done using INRIX Trip Analytics (*INRIX*, 2022). The goal of this task was to determine traffic volumes traveling from origins to major destinations through major highways. This enabled identification of major tourism routes and the priority origin markets. Only major highways were included in our analysis because trip and traffic data in INRIX Trip Analytics are limited to major roads. The analysis of trips was done at the county level since most of the attractions were clustered together at this geographical resolution. It is worth noting that INRIX supports analysis at smaller geographical resolutions such as sub-county, TAZ, and ZIP levels. This, however, is computationally demanding with the resulting visualizations difficult to follow particularly when origins and destinations are scattered over larger geographical regions, e.g., out of state. Additionally, results from survey of tourists indicated that about 64% of recreational travels were undertaken between April and August (Figure 4-8). Therefore, to reduce the computational times our analysis included trips made between April 2021 to August 2021. Only light and medium vehicle trips were included in our analysis.

3.4.3 Analysis of popular tourist routes

3.4.3.1 Identification of O-D pairs for analysis

As mentioned before, the national long distance passenger travel demand is a tour-based simulation model for generating long distance travel behavior and patterns. The long-distance model first estimates tour generation, scheduling, duration, and party-size models by tour purposes. After that, the model generates individual and origin-destination matrix for different modes and trip purposes. Tour purposes for national long-distance travel includes leisure and vacation, visit to friends or relatives, personal business, commuting, and employer's business. Four modes can be modeled in accomplishing the estimated trips by purpose, which are personal cars, intercity bus, intercity rail, and commercial air travel. Figure 3-6 represents the structure of the tourism long-distance travel demand modeling system. As seen from the figure, final models from rJourney produce individual tours with purpose, duration, and month. Also, the mode and destination choice model produce individual tours with mode and destinations all over the US. In addition to that, the microsimulation model produces number of trips for auto, bus, rail, and air mode for different O-D pairs based on the NUMA zones.

Using the long-distance trips O-D matrix for four different modes, total trips made between the NUMA zones are quantified. After that, the O-D pairs were filtered by selecting the pairs that had both origins and destinations within the state. Once the O-D pairs within Tennessee are selected, these pairs are sorted in a descending order based on the total number of trips made between them. Based on the total trips, the top 10 O-D pairs within the state were selected.

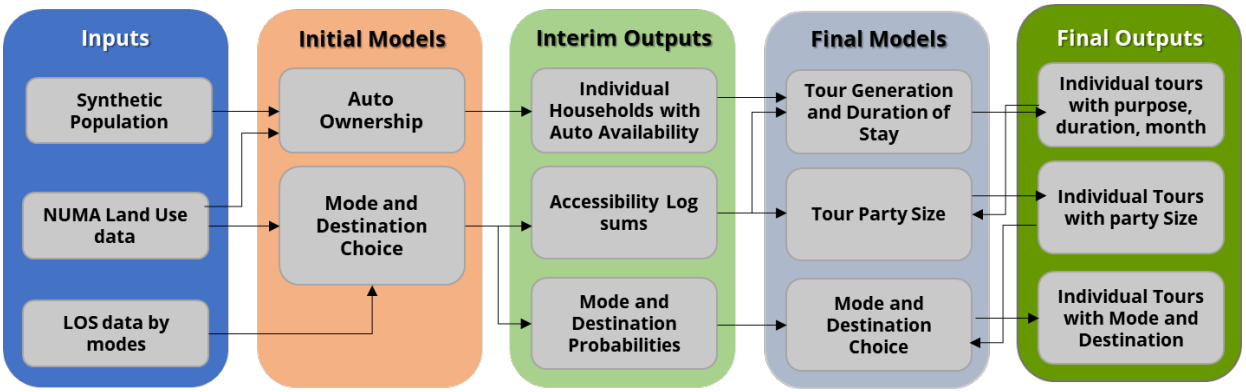


Figure 3-6 Identification of O-D pairs for analysis route analysis

3.4.3.2 Analysis of traffic conditions on popular routes

After identification of O-D pairs, major routes used for traveling between the O-D pairs on Weekdays and Weekends was identified using INRIX Trip Analytics. Trips were analyzed for the months April to August in 2019. TTI was then calculated for the most used route to check traffic conditions on the route on weekdays and weekends.

3.5 Transportation services for tourism in Tennessee

In the fifth step, an online survey was administered to tourism agencies across the state to gather information on the current state of transportation services in the state. These agencies included chambers of commerce and local agencies that are responsible for developing tourism in their area/jurisdiction. The list of agencies for the survey was compiled from the TDTD website and 2022 Tennessee Vacation Guide (*The Soundtrack of America: Made in Tennessee (2022 Vacation Guide)*, 2022). The list of agencies is provided in Appendix E. The survey administered on the agencies consisted of questions associated with the agencies' perception of current state of transportation services in their area and the state, collaboration between agencies, issues in transportation systems, and measures to address them. The survey was developed in Qualtrics and emailed to the agencies along with a brief description of its objectives. The online survey took about 8 minutes to complete. Of the 50 agencies that responded to the survey, 33 were complete. Summary of these complete responses is presented in Chapter 4: Results and Discussion.

Chapter 4 Results and Discussion

4.1 Survey of state DOTs and STOs

The survey of state DOTs and STOs included questions on specific tourism related travel demand modeling practices, tourism data sources and data analysis methods, tourism inclusive project selection practices, and collaboration manner between diverse tourism stakeholders. A brief discussion of responses obtained on interagency collaboration and private sector involvement in tourism transportation planning based on the survey is presented in the following two subsections. As outlined in the Methodology section, analysis of survey responses was done using *k*-means clustering which is detailed in Appendix A and summarized here.

4.1.1 Discussion of the Survey result

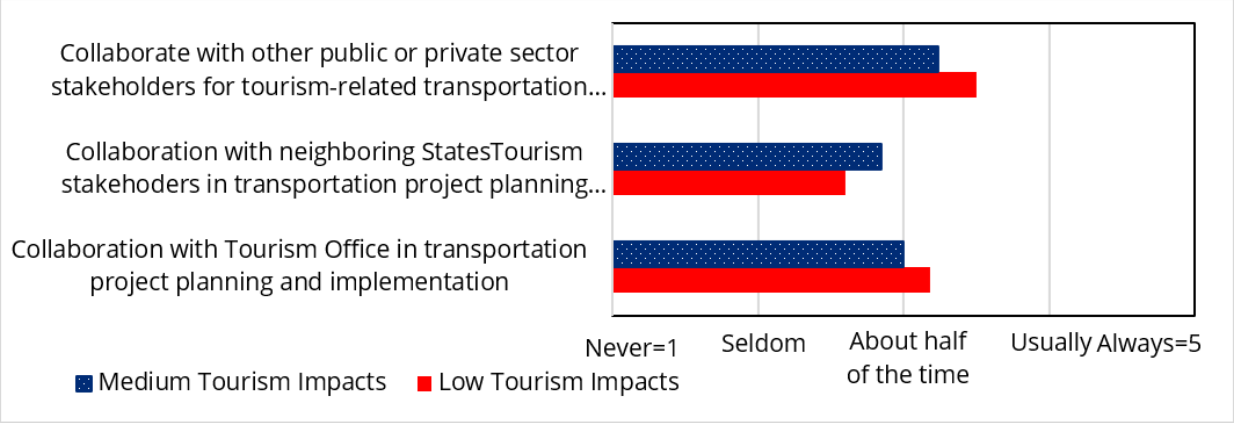
After application of the clustering technique, IPF was used to generate data for states that did not respond to the survey using the collected survey data. IPF method was applied to each cluster so that the generated synthetic data was more representative within each cluster. The clusters were compared based on the collected and synthetic survey data related to agency collaboration and private sector involvement, which are provided in the following sections (Ashraf et al., 2022). This discussion focuses mainly on medium tourism impact states and low tourism impact states. The reader may refer to Appendix A for a detailed description of classification of states based on tourism impact.

4.1.1.1 Interagency collaboration in tourism transportation planning processes

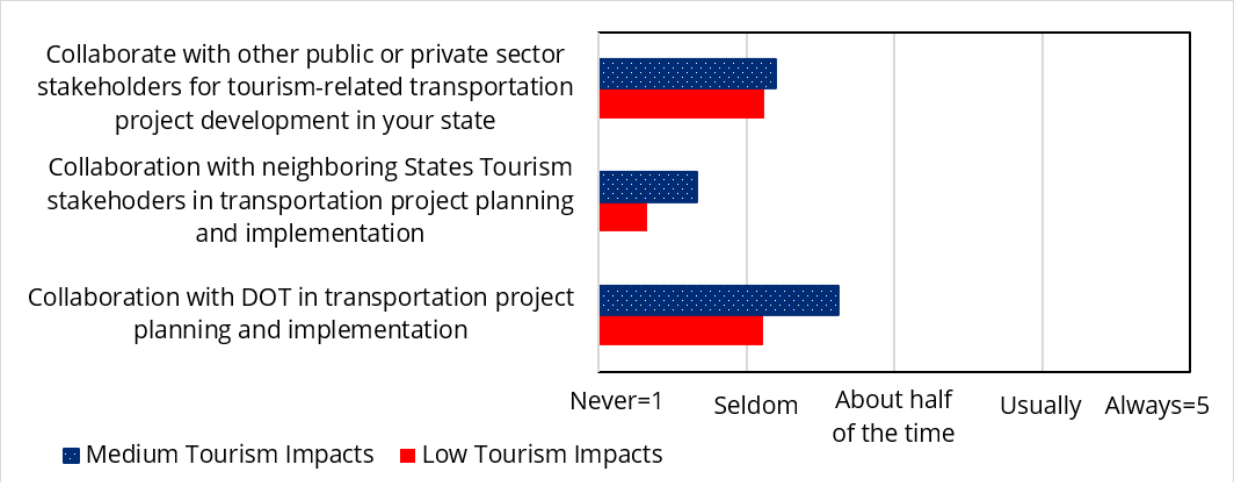
Collaboration between state DOTs and STOs is critical in developing successful tourism supporting transportation infrastructure and services (Petraglia & Weisbrod, 2004). State DOTs and STOs were asked to select the nature of their current interagency collaborations. In general, the survey results showed a lack of effective collaboration. DOT responses showed that collaboration with STOs in transportation project planning and implementation was close to the average for low and medium tourism impact states (Figure 4-1 (a)). It should be noted that in Figure 1, the average responses are scaled from Never (1) to Always (5). Among the STO respondents, medium tourism impact states had better transportation infrastructure and services for the tourism industry than low tourism impact states (Figure 4-1 (b)). This implies that better transportation infrastructure contributed to the economic impacts of tourism in medium tourism states compared to low tourism impact states. States in the medium tourism impact cluster had a better collaboration with state DOTs, neighboring state's STOs, and public and private sector stakeholders. Collaboration with state DOTs was close to the average for medium tourism impact states and below average for low tourism impact states. Regarding collaboration with other public and private sectors in tourism-related transportation project development, states in the lower tourism impact cluster had slightly better practices than other states. However, the frequency of collaboration with neighboring state DOTs and STOs in planning and implementing tourism transportation projects was still less than "half of the time" for medium and low tourism impact clusters. In collaboration practices, states with medium tourism impact were better than those within low tourism impact clusters.

State DOTs and STOs were also asked about the primary obstacles to effective interagency collaboration and actions/policies that can be taken to improve it. About 28% of the state DOTs and 33% of the STOs stated identified lack of established policies as the primary obstacle. Lack

of funding was another obstacle identified by the responding agencies. The agencies mentioned that state-level policies focused on collaboration need to be developed and set a requirement in the project selection process to increase collaboration among tourism stakeholders.



(a) State DOT perspective



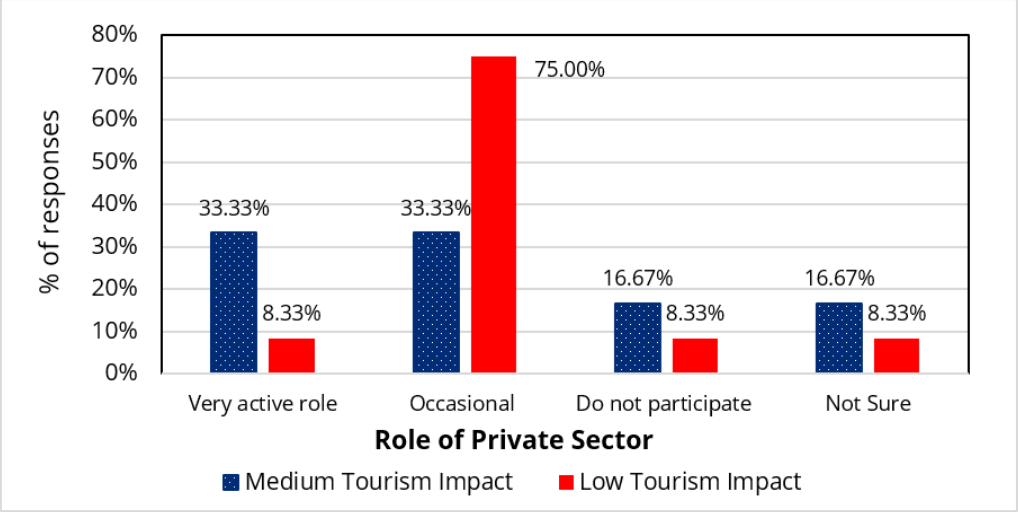
(b) STO perspective

Figure 4-1 Collaboration manner among state DOTs and STOs.

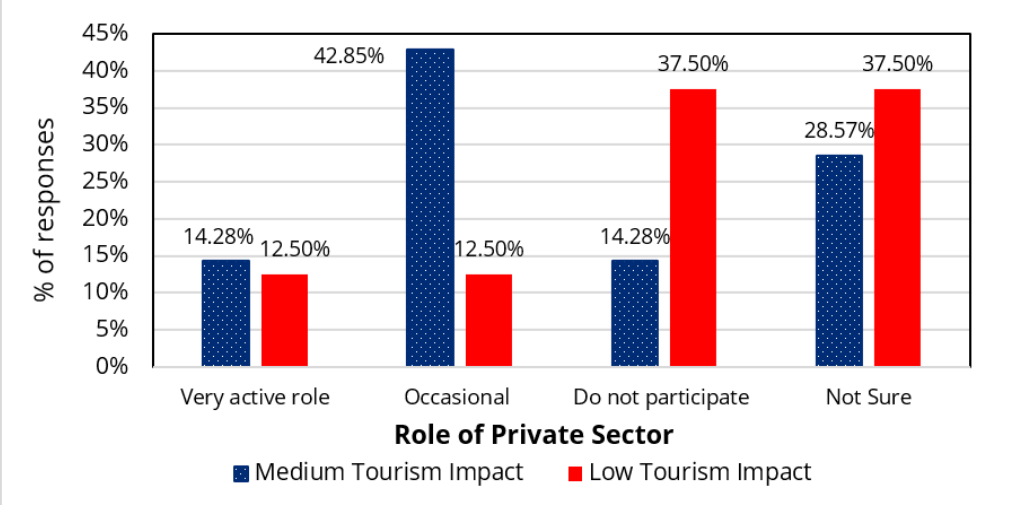
4.1.1.2 Private sector involvement

NCHRP Report 419: Tourism Travel and Transportation System Development identified eleven principles to promote tourism and associated economic activity in the traditional transportation planning and project development process (Frechtling et al., 1998). The involvement of private sector stakeholders in tourism-related transportation planning was one of the critical elements of these principles. 15 states (33% of states) in the medium tourism impact cluster reported that the private sector plays an active role in tourism-related planning. On the other hand, only 9% of state DOTs (3 out of 32 states) in the low tourism impact cluster reported the same for tourism-related transportation infrastructure and service planning (Table 4-2 (a)). In addition, 42% (6 states out of 15) of the STOs in the medium tourism impact cluster and 12.5% (4 states out of 32) of the state tourism offices of low tourism impact cluster occasionally engage in transportation project selection (Table 4-2 (b)). The responses also provided insights into their agency's role in

tourism-focused transportation systems and service-related investment decision-making. 85.71% and 71.4% of tourism agencies reported they play a supporting role in tourism-related transportation project selection and implementation in medium and low tourism impact clusters. Overall, there is a lack of private sector involvement in the tourism and transportation-related project selection process, and it should be addressed to realize the economic impacts of the tourism sector.



(a) State DOT perspective



(b) STO perspective

Figure 4-2 Role of private sector stakeholders in tourism transportation service development

4.2 Analysis of tourist trip characteristics

4.2.1 Summary of trip characteristics

4.2.1.1 Sociodemographic characteristics of tourists

This section presents a summary of results from a survey administered on tourists who visited recreational destinations in Tennessee in the past.

Figure 4-3 presents the distribution of tourists' socio-demographic attributes. Clearly, almost half of tourists visiting the state are young individuals less than 25 years old. Almost 32% of visitors are full-time employees. Notably, the state is more popular among retired individuals who account for more than 33% of all tourists. The distribution of the tourists' personal annual income suggests that tourists from all income classes travel to Tennessee. The marital status of tourists suggests that there were more married and single individuals visiting Tennessee.

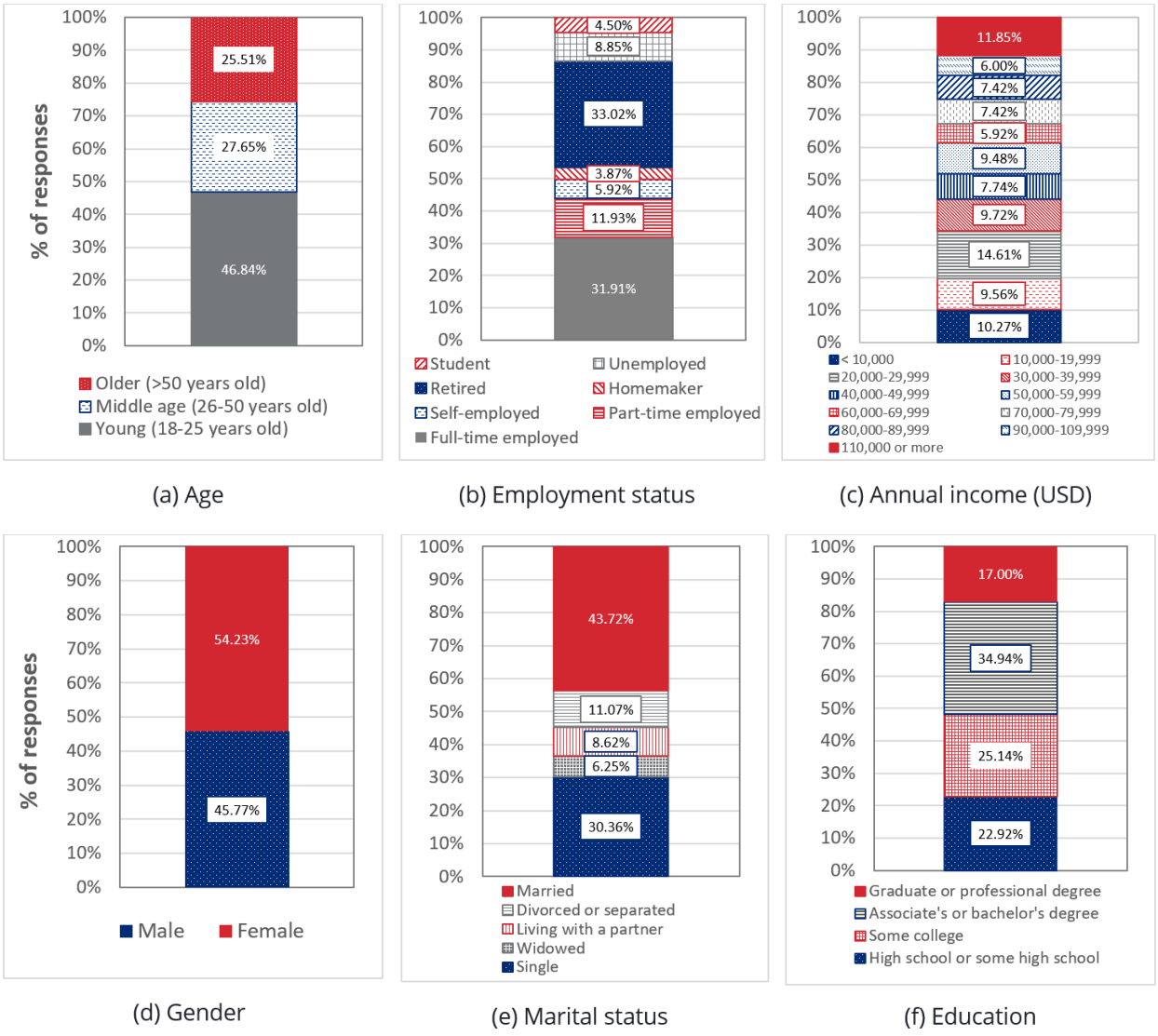
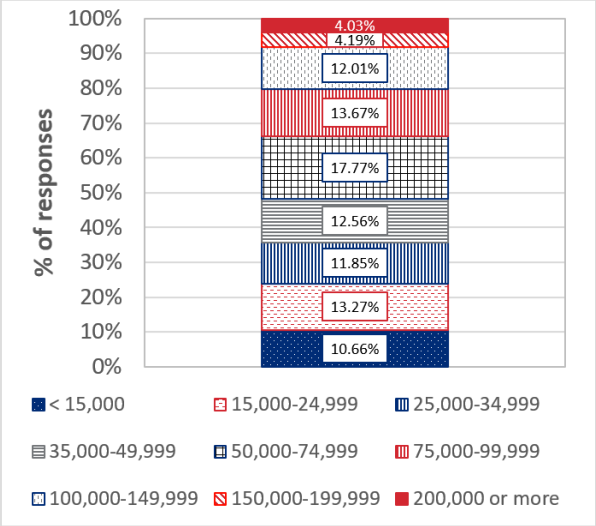


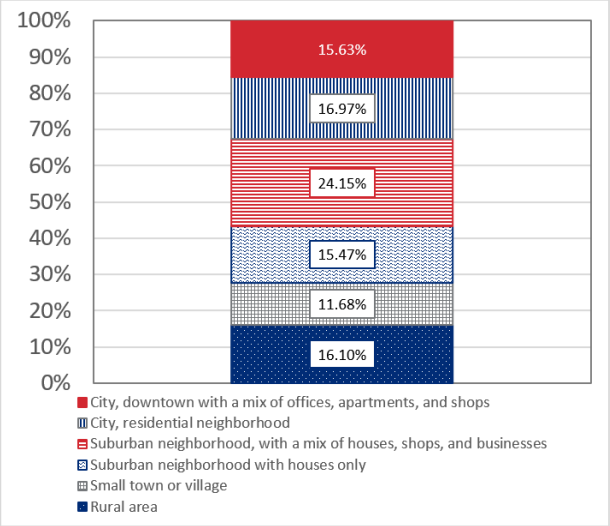
Figure 4-3 Socio-demographic characteristics of tourists visiting Tennessee

4.2.1.2 Household characteristics

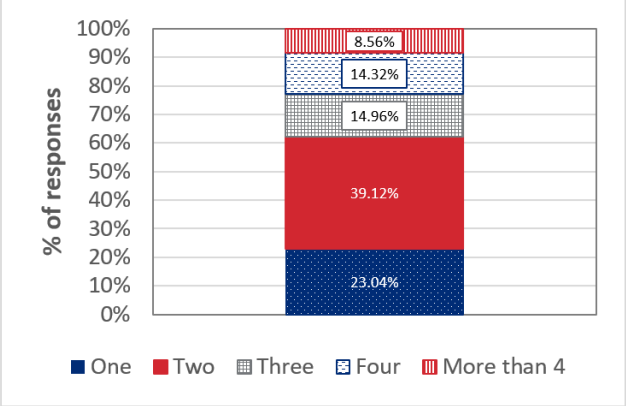
Household characteristics of travelers presented in Figure 4-4 indicates that household income, as with personal income, has no considerable influence on travelers. People living in rural or sub-urban areas constitute about 68% of tourists. People belonging to smaller households are more likely to visit Tennessee. While it seems that households with 3 more vehicles are less likely to visit the state, it could be that these households were less in number since this variable was not controlled using quota sampling when conducting the survey.



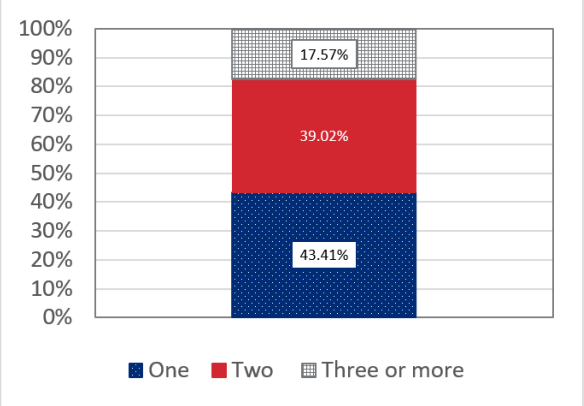
(a) Household income in USD



(b) Location of residence



(c) Number of members in household



(d) Number of vehicles in household

Figure 4-4 Household characteristics of tourists visiting Tennessee

4.2.1.3 Travel mode and duration of stay

Figure 4-5 shows primary mode used to travel to Tennessee by distance traveled. Almost 40% of visits are more than 500 miles away from their origin. Regardless of the distance, majority of trips are made using household or owned vehicles. About 8% of trips more than 500 miles are made using private or commercial airplanes. Notably, with an increase in travel distance there is a consistent increase in air travel.

Figure 4-6 shows distribution of duration of stay. We can see about 60% of visitors stay from 2-4 nights at the destination.

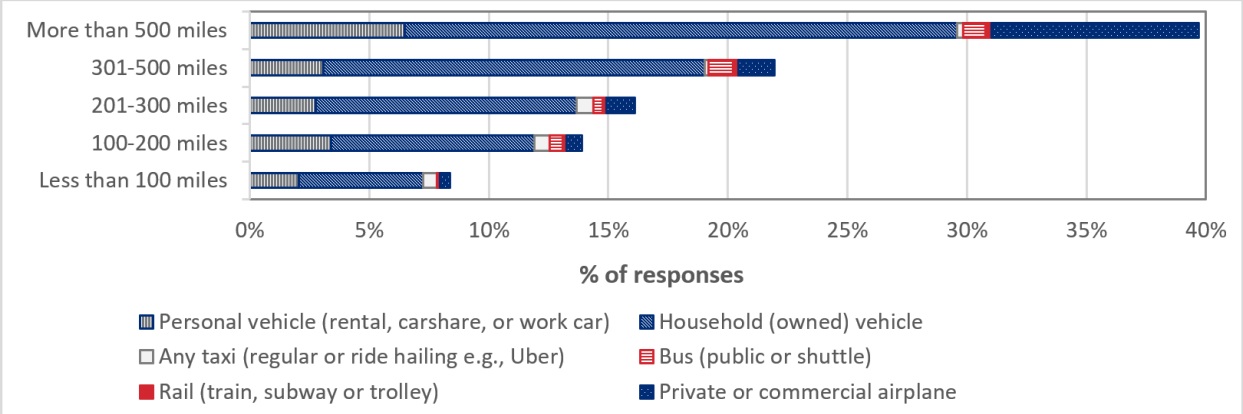


Figure 4-5 Travel mode by distance traveled

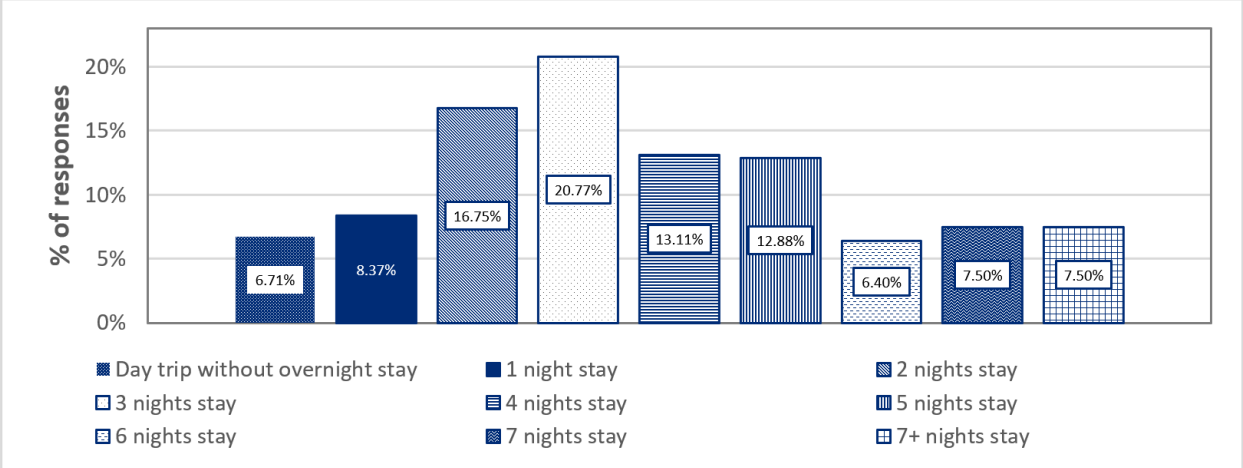


Figure 4-6 Duration of stay at destination

4.2.1.4 Satisfaction of tourists

Satisfaction of tourists for various aspects of tourism was collected using a 10-point Likert scale from 1-Poor to 10-Excellent. In general, high satisfaction ratings were observed across all aspects. Notably, satisfaction for value for money was comparatively less than other aspects.

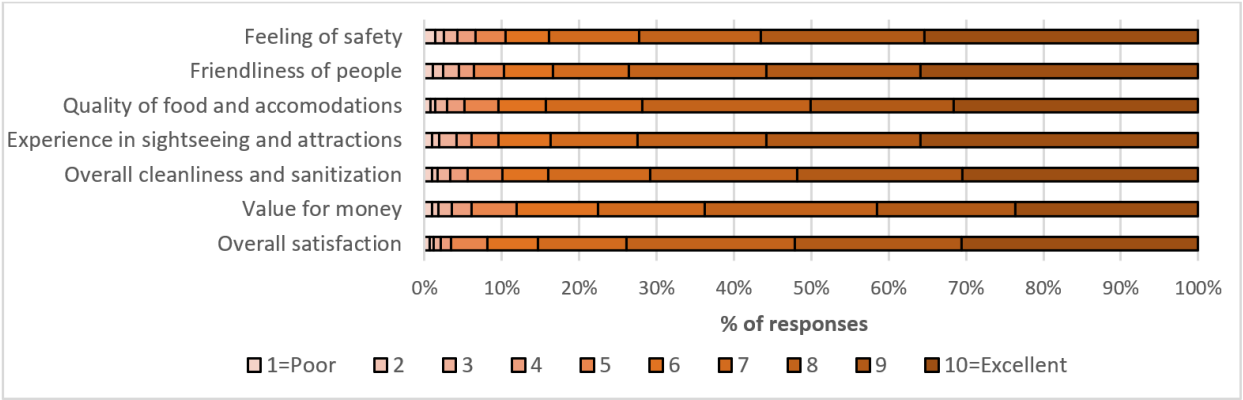


Figure 4-7 Satisfaction ratings from tourists traveling to Tennessee

4.2.1.5 Trip timing

Figure 4-8 shows how tourism travel is distributed across a year. Typically, tourism travel peaks in June. April, May, June, July, and August together account for about 64% of all travels made to Tennessee. Summer breaks could be a reason for this.

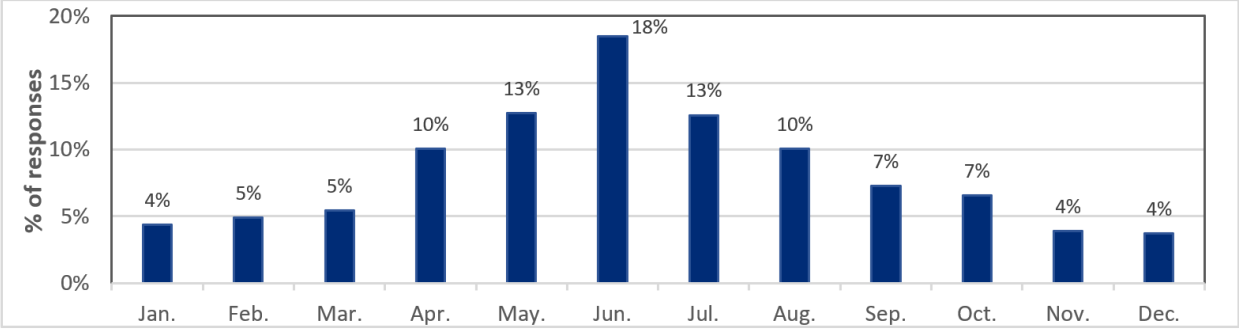


Figure 4-8 Distribution of travel across a year

4.2.1.6 Trip frequency

Figure 4-9 presents recreational frequency of tourists who responded to the survey. More than three fourths of all respondents indicated that they traveled at least once a year.

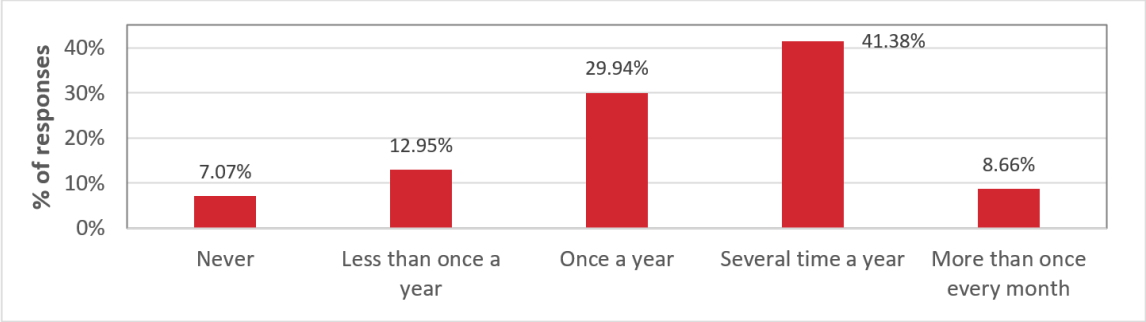


Figure 4-9 Recreational travel frequency of tourists

4.2.2 Antecedents to recreational travel intentions

4.2.2.1 SEM Analysis

The analysis of survey responses related to recreational travel attitudes during the COVID-19 pandemic was done using SEM (Thapa et al., 2022). The survey data was first tested for sampling adequacy using Kaiser-Meyer-Olkin's measure and found to be excellent with an overall value of 0.91. Bartlett's test of sphericity was also found to be excellent with $p < 0.001$. Exploratory Factor Analysis (EFA) was conducted on the attitudinal questions (also called indicators in SEM) using varimax rotation and a cutoff of 0.4 for factor loadings (Guadagnoli & Velicer, 1988). This resulted in ten factors (also called constructs or latent variables) that captured a cumulative variance of 63%. Cronbach's alpha for all the extracted factors was greater than 0.75 and therefore satisfactory (Faul et al., 2009). Results from factor analysis is outlined in Appendix B. The extracted factors were used to create SEM model outlined in Figure 3-2. Model fit indices for the model were also satisfactory with $\chi^2 = 7334.07$; df = 2066; p = 0.00; Root Mean Square Error of Approximation (RMSEA) = 0.045, 95% CI = [0.044, 0.046], PCLOSE = 1.00; Tucker-Lewis Index (TLI) = 0.94; Comparative Fit Index (CFI) = 0.95. The consensus regarding the cutoff values for good fit indices are: RMSEA < 0.05, PCLOSE > 0.05 (higher the better); TLI > 0.9; and CFI > 0.9.

The measurement and structural equation models for our SEM are also provided in Appendix B. A summary of decisions for our hypotheses is presented in Table 4-1. Note that for hypothesis H2a, the relationship was statistically significant but with an inverse relationship of what was proposed, therefore it is not supported. The decision on the remaining hypotheses is based on the statistical significance of their path coefficients.

Table 4-1 Summary of results for hypotheses used in investigating travel intentions

Hypotheses	Relationships	Path coefficient	t-stat	Decision
H1a	Public trust → Travel attitude	0.54*	12.14	Supported
H1b	Public trust → Behavioral intention	0.27*	8.56	Supported
H1c	Public trust × Travel concern → Behavioral intention	-0.07*	-2.21	Supported
H2a	Subjective norm → Travel attitude	-0.36*	-10.48	Not supported
H2b	Subjective norm → Behavioral intention	0.39#	9.03	Supported
H2c	Subjective norm × Travel anxiety → Behavioral intention	-0.02	-0.60	Not supported
H2d	Subjective norm → Travel composure	0.45#	11.91	Supported
H3	Travel attitude → Behavioral intention	-0.02	-0.57	Not supported
H4a	Perceived behavioral control → Travel composure	0.26#	7.08	Supported
H4b	Perceived behavioral control → Behavioral intention	0.45#	10.03	Supported
H5	Travel composure → Behavioral intention	0.04	1.08	Not supported
H6a	Perceived knowledge → Perceived benefits	0.24#	7.36	Supported
H6b	Perceived knowledge → Behavioral intention	0.07	1.65	Not supported
H7	Perceived benefits → Behavioral intention	0.54#	12.17	Supported

*Significance levels: *0.05, #0.001. Exceptions are statistically insignificant at 5% level of significance.*

4.2.2.2 Necessary Condition Analysis

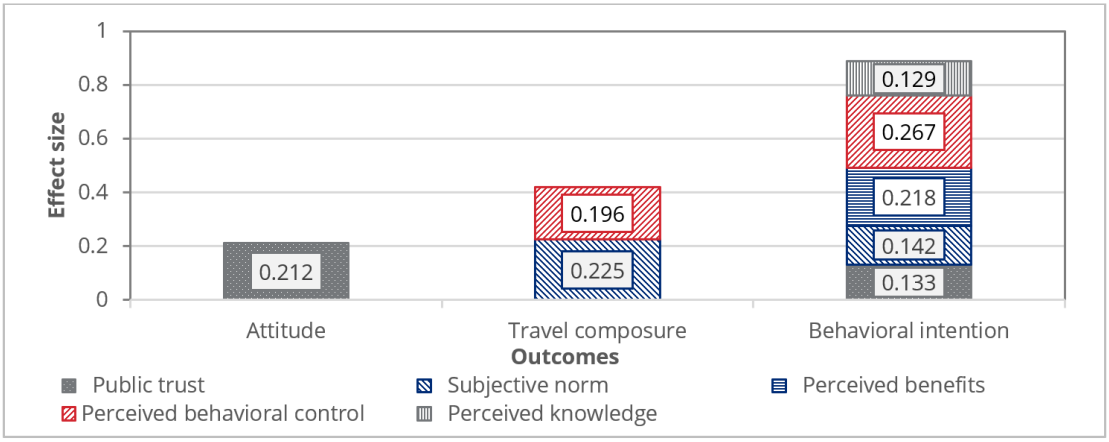


Figure 4-10 NCA effect sizes (All effect sizes significant at p=0.01)

Figure 4-10 shows the effect sizes of the predictor variables. The stacked bars represent the outcomes with the effect from each predictor endogenous latent variables within them. Note that the height of the bars represents the cumulative effect of all its predictors. Following our rationale for determining necessary conditions, only the predictors with $d \geq 0.1$ at a 5% level of significance are considered to have a measurable effect and therefore presented in the figure.

The effect of endogenous latent variables with *0.1< d < 0.3* suggests medium effects. Notably, the effect sizes of trust on attitude; subjective norm on comfort; perceived benefits, and perceived behavioral control on behavioral intention is greater than 0.2. No significant effect sizes were found for attitude, travel concern, travel anxiety for behavioral intention at a 5% level of significance. The moderating effect of trust on travel concerns was found to be statistically insignificant. Similarly, perceived behavioral control and subjective norm are necessary in defining travel composure. Finally, public trust, subjective norm, perceived benefits, perceived behavioral control and perceived knowledge are necessary to manifest intention.

The bottlenecks for predictors with medium effects are presented in the Appendix B and may be interpreted as follows. A certain value of the predictor variable is necessary for a certain effect to be manifested in the response variable. This amount is presented as a percentage of the maximum value of the variable.

The interpretation of results from SEM and NCA can be based on three scenarios which are stated below. Within the parenthesis, we also present the predictors and outcomes for which each scenario was observed. In our analyses, only the latent constructs shown in Figure 4-10 were significant in NCA (Scenarios 1 and 2 of possible scenarios for interpretation of the necessary condition discussed below. A more detailed description is included in Appendix B). This suggests a certain level of these variables is necessary for the outcome to manifest. These levels are shown as bottlenecks in Figure B-1 in Appendix B.

1. Predictor is significant in SEM and NCA **[Scenario-1]**: A change in the predictor variable will change the outcome but a certain level of the predictor variable is necessary for the outcome to manifest. (*Subjective norm → travel composure, perceived behavioral control → travel composure; public trust → behavioral intention, subjective norm → behavioral intention, perceived benefits → behavioral intention, perceived behavioral control → behavioral intention*)
2. Predictor is not significant in SEM but significant in NCA **[Scenario-2]**: A certain level of the predictor variable is necessary for the outcome to manifest but a change will not affect the outcome. (*Public trust → travel attitude; perceived knowledge → behavioral intention*)
3. Predictor is significant in SEM but not in NCA **[Scenario-3]**: Change in the predictor variable will change the outcome and no necessary condition exists for the predictor variable to manifest the outcome. (*Subjective norm → travel attitude; perceived knowledge → perceived benefits*)

   For this scenario, we find that no minimum levels of travel anxiety and concerns are necessary to manifest travel intention, but they are sufficient to manifest the outcome. A similar effect of subjective norm and perceived knowledge on travel attitude and perceived benefits respectively is also observed.

4.2.3 Conclusion and implications

Findings from investigation of travel intentions have far-reaching implications in terms of policy considerations. The relationship between public trust and travel attitude in NCA suggests that public trust in government is essential in developing a positive travel attitude (Q. Han et al., 2021). Also, travel intentions can be promoted if the public's knowledge of the pandemic is increased. Better dissemination of COVID-19 related knowledge is also crucial to keep people informed so they have higher perceived knowledge to develop travel intentions. Dissemination of correct

information through government channels can also increase travel intentions by developing trust in the public. Campaigns to keep the public informed can be helpful in this regard. Secondly, the public's perceived benefits also have a measurable effect on intentions. Better incentives with flexible booking and cancellations can also potentially increase perceived behavioral control and therefore travel intention. Although compared to public trust, the necessary condition for the subjective norm is lower, favorable subjective norm could follow with better knowledge of the pandemic. Our finding suggests that subjective norms can reinforce travel intentions. It is logical to assume that subjective could improve with public trust and perceived benefits. Therefore, we recommend better information dissemination and providing travel incentives as the two most crucial measures that can be adopted at the policy level for the quick economic recovery of the travel industry.

4.3 Analysis using national long-distance travel model

The results from the four scenarios analyzed using the national long-distance passenger travel demand model are as follows.

4.3.1 Scenario 1: Impacts of transit access improvement

Transit system accessibility measures physical access to public transit stops by evaluating the distance, time, and convenience of accessing transit stops (Malekzadeh & Chung, 2020). In this scenario, transit accessibility was improved by increasing bus and rail stops, and higher number of airports within certain distance from each TAZ (discussed in the next section). The resulting mode share under the increased transit accessibility scenario was compared with the base case scenario. Figure 4-11 shows the change in mode share due to change in transit accessibility. As expected, when there is better access to transit services, people would use them (rail and bus) and air travel more frequently for long-distance trips. On the contrary, the use of personal cars would decrease. Specifically, use of personal car could decrease by 0.93%-1.98%. The corresponding increase in mode share for bus, rail, and air could be 0.11%-0.35% and 0.18%-0.36%, 0.64%-1.34%, respectively.

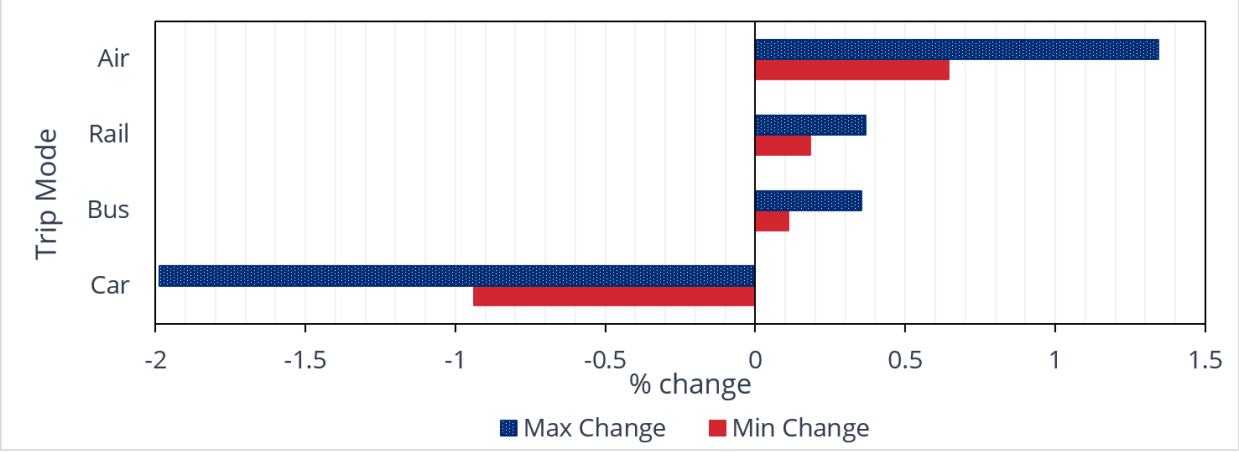


Figure 4-11 Results from Scenario 1: Change in mode share in Tennessee

These potential impacts of transit accessibility increase can be used in tourism policy development for promoting sustainable transportation services for tourism in Tennessee. The change in mode share under increased transit access indicates that people could use more public

transit services if the service is widely available. Figure 4-12 shows the top twenty O-D pairs for long-distance travel for trips that had both origin and destination within the state, and most trips were centered around Knoxville. Policy makers can use the O-D pairs to prioritize transit service improvement focusing on long-distance trips. With limited resources, O-D pairs with more long-distance trips could be prioritized for new services or any existing transit services between those zones can be improved. In addition, new routes and more frequent transit services can be introduced along the most frequent O-D pairs.

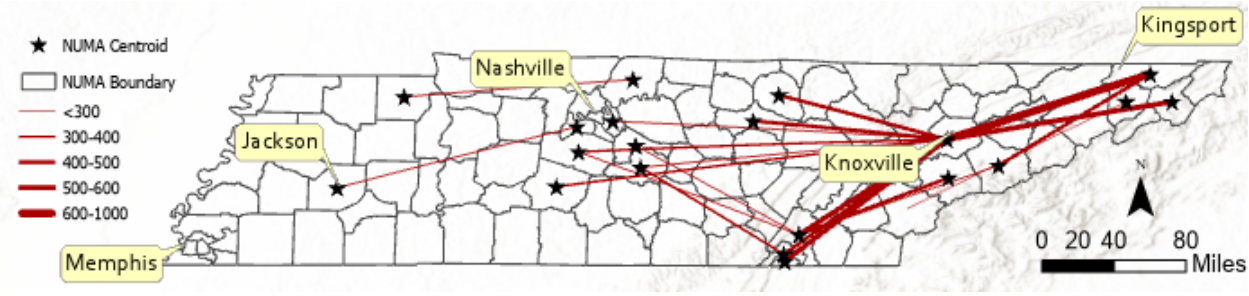


Figure 4-12 Top 20 O-D pair under increased transit access scenario

4.3.2 Scenario 2: Impacts of air fare policy on tourism travel

One potential policy to promote more frequent tourism trips is to reduce fares for travel modes serving major tourist destinations. In this scenario, air fare was decreased by 30% to 50% to estimate associated impact on mode share and volume of long-distance trips. The change in mode share is shown in Figure 4-13. The increase in long-distance trips using air mode could mostly replace long-distance trips using personal cars. The estimated increase in mode share for air is 1.98% and 1.45% for 50% and 30% air fare reduction, respectively. On the other hand, the estimated decrease in personal car trips is 1.8% and 1.3% for 50% and 30% air fare reduction, respectively. Mode share for bus and rail can also be expected to decrease under this scenario although the estimated change is not as large as compared to personal car and air travel. Under this scenario, the distribution of trip purposes could also change.

According to the tourist survey undertaken during this project and also past studies, the two most widely used modes of tourism travel are air and personal cars (Speakman, 2005). The findings of this research indicate that reducing air fares can increase tourism trips substantially. People could be more encouraged to perform tourism trips if statewide tourism policy reduces air and transit fares. A previous study has reported an increase in transit ridership when transit fares are reduced and targeted to serve specific user groups (Darling et al., 2021). Thus, the transit fare reduction can be targeted towards tourism trips via promotional initiatives and policy levels to assess the proper balance between tourism development and revenue generation.

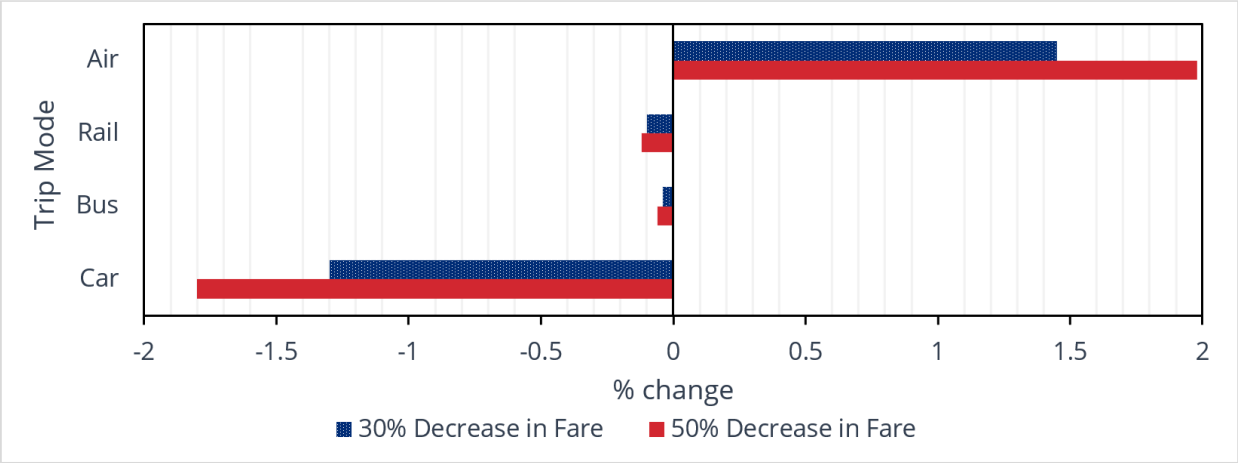


Figure 4-13 Result from Scenario 2: Change in mode share due to reduced air fare

4.3.3 Scenario 3: Impacts of lower congestion along major tourist routes

Traffic congestion along major tourist corridor degrades tourism travel experience and reduces tourism trips (Virginia Tourism Corportation, 2013). In this context, it is necessary to simulate the effect of congestion on long-distance trips. The reduced congestion scenario was simulated by reducing the auto travel time by 25% to 50% for the long-distance trips based on past research (Outwater et al., 2015). The resulting change in long-distance trip generation pattern in Tennessee is shown in Figure 4-14. It is observed that most of the NUMA zones could experience an increase in long-distance trips under reduced congestion scenario. However, several areas could also experience no change in auto trips as shown in the figure.

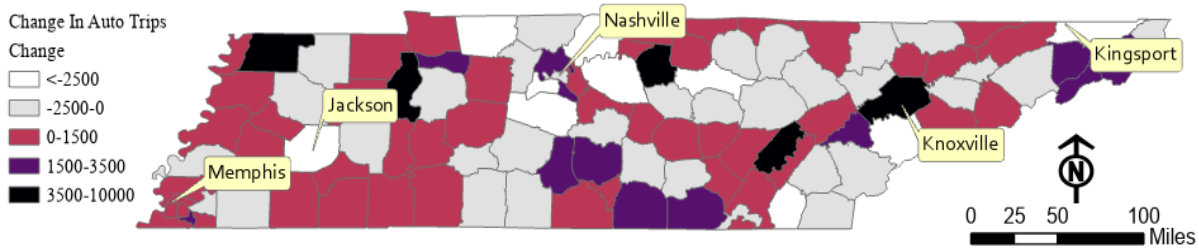


Figure 4-14 Result from Scenario 3: Change in long-distance trips under reduced congestion

4.3.4 Scenario 4: Impacts of increase on household Income

In this scenario, the household income was raised by 15%-30% to investigate its statewide impact on long-distance trips. With the increase in household income, people are expected to make more long-distance trips using personal cars (Virginia Tourism Corportation, 2013). With an increase in household income people reduce long distance trips using public transit services. Comparison of this scenario with base scenario shows that, for a 15% to 30% increase in household income 5.8%-6.2% increase in long-distance trips using personal cars can be observed as shown in Figure 4-15. Subsequently, there were 1.25%-1.46%, 0.14%-0.16% and 4.4%-4.5% decrease in the share of bus, rail, and air modes, respectively.

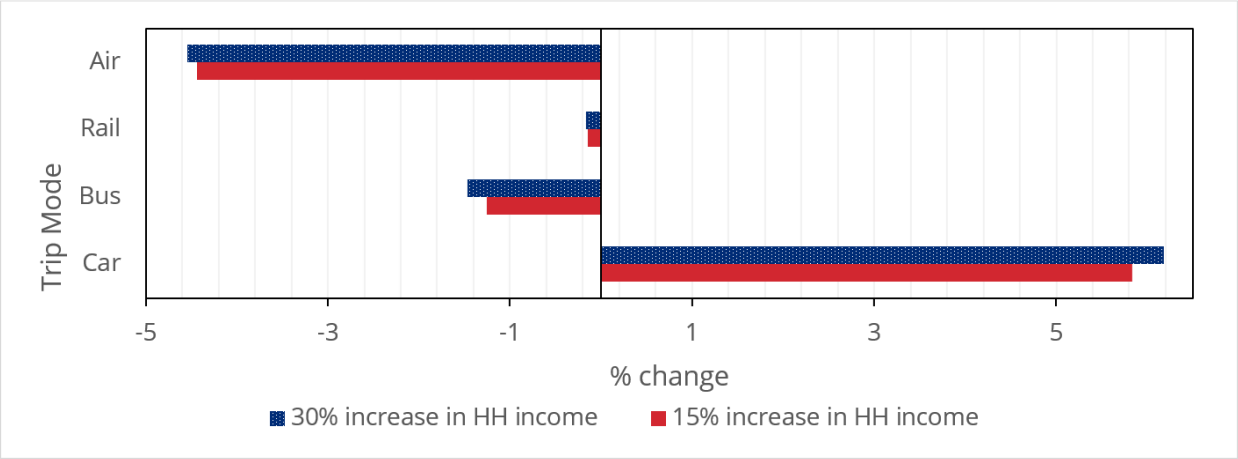


Figure 4-15 Result from Scenario 4: Changes in mode share with increased household income

An increase in household income is expected to influence tour purposes for long-distance trips, as shown in Figure 4-15. Higher household income could increase leisure commute, and employer's business trip shares. Conversely, visiting friends and relatives, and personal trips could decrease with higher household income. From our analysis, we observe the leisure trips increases by 0.93% for 30% increase in income as shown in Figure 4-16. Policymakers should take future transportation improvement projects considering the increased intra-state demand from tourism travel resulting from changes in household income.

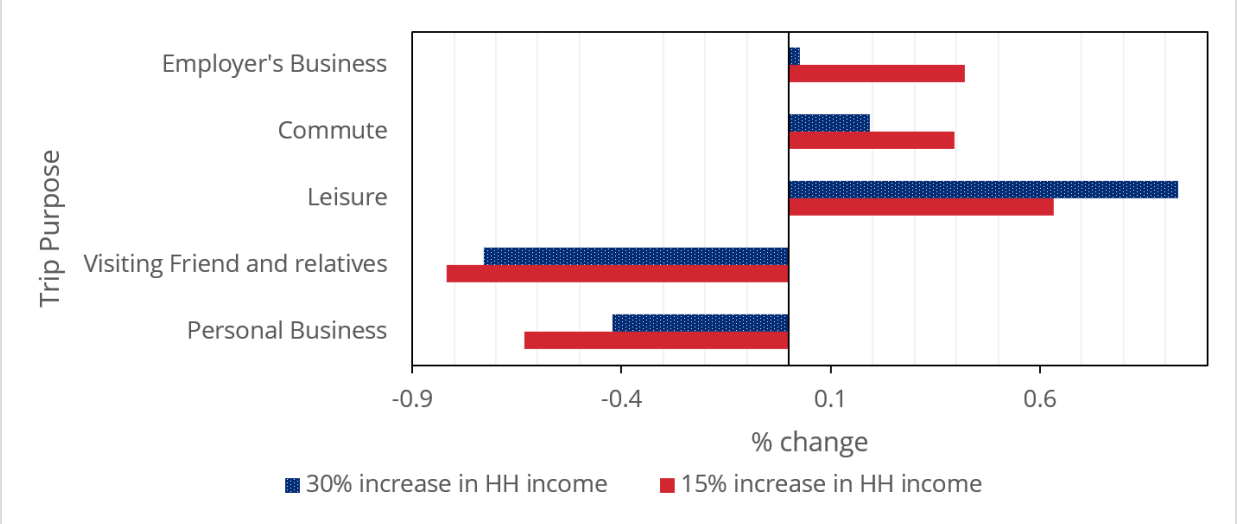


Figure 4-16 Result from Scenario 4: Changes in trip purpose with increased household income

4.3.5 Conclusion and implications

In this task, different scenarios based on transit accessibility improvement, reduced congestion, reduced air fare, and increase in household income were developed to study future long-distance tourism travel in Tennessee. Scenario analysis indicates that improving transit accessibility could promote sustainable tourism transportation services. Further, tourists' experience can be improved by reducing congestion near the popular tourist destinations and along popular tourism corridors. Policies that promote reduced transit fares can also promote tourism by

diverting people away from using personal cars and relieving congestion. In addition, increase in household income could generate more tourism trips mainly from the use of personal cars. This should be given due consideration when planning for future transportation system and services.

It is worth mentioning here that O-D analysis can be performed to identify patterns in long-distance travel and prioritize areas and corridors for transit service improvement. Due to limitations of the rJourney software (can model up to 4,700 zones), long-distance travel models that consider smaller TAZs could be employed for in-depth analysis of policy impacts that are associated with sustainable tourism system and services.

4.4 Analysis of popular destinations

4.4.1 Access to popular attractions

4.4.1.1 Access from nearest urbanized area

Analysis of access to tourist attractions was assessed based on distance and travel time. Travel distance and travel times from nearest UA to the destinations are shown in Figure 4-17. The origin UA and the destination is presented in the axis label. Destinations located within a UA are not shown in the plot. Of the 28 attractions outside UAs, 18 are within 40 miles or an hour drive from the nearest UA.

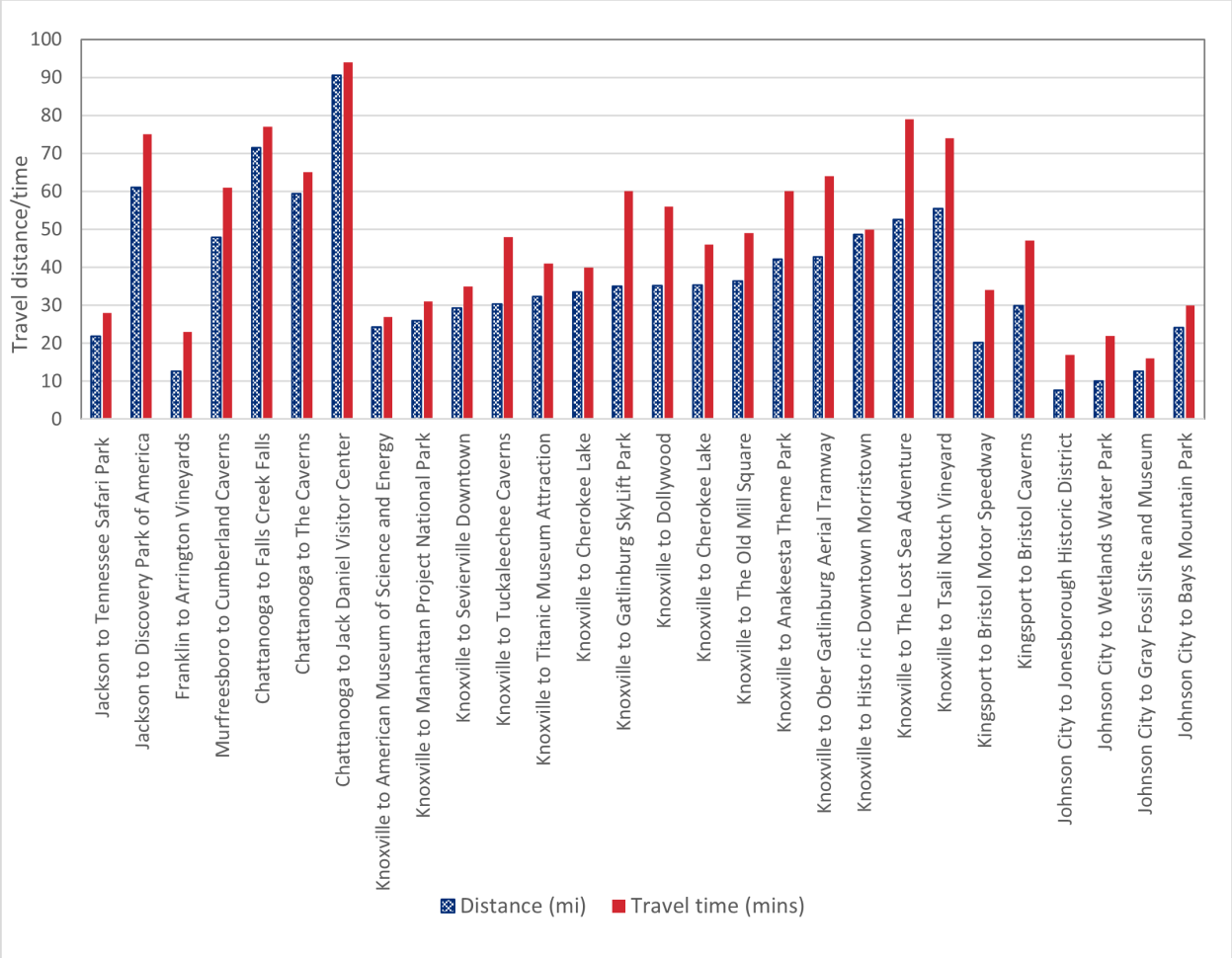


Figure 4-17 Access to destinations from its nearest UA

3.4.1.2 Access from nearest primary service commercial airport

Thirty nine of the fifty attractions are within 40 miles or an hour drive from the nearest primary commercial airport (see Figure 4-18). The travel time and distance are proportionate for all attractions except those located in Gatlinburg (Gatlinburg SkyLift Park, Anakeesta Theme Park, Ober Gatlinburg Aerial Tramway). The travel time to these attractions is notably larger than the travel distance.

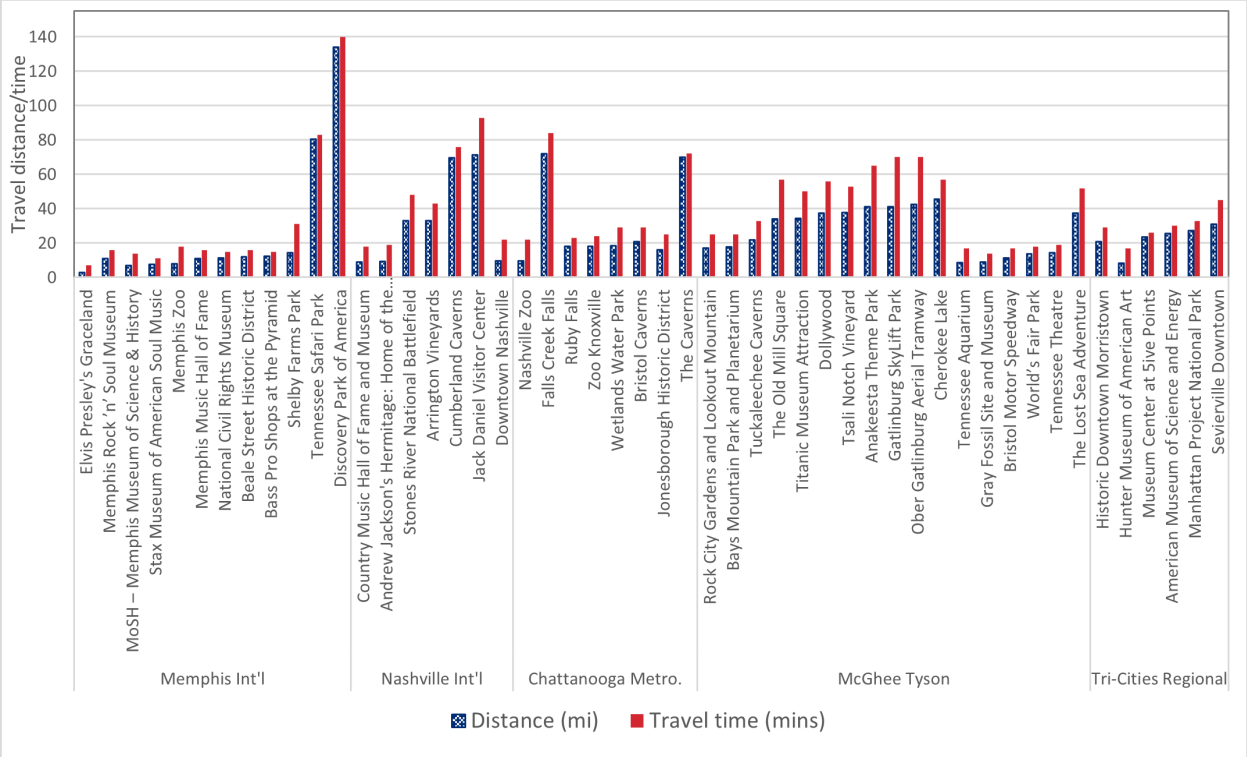


Figure 4-18 Access from nearest primary service commercial airport

3.4.1.3 Access from nearest interstate and transit stops

Results showed that almost all attractions are within 40 miles of an interstate exit. A notable observation was the large discrepancy between travel distance and travel time when traveling from nearest interstate exit on I-40 to attractions in Gatlinburg. Similar observation was made for access from nearest primary commercial airport to the attractions. Compared to others, the travel times to these attractions were notably longer considering the distance traveled (Figure 4-19).

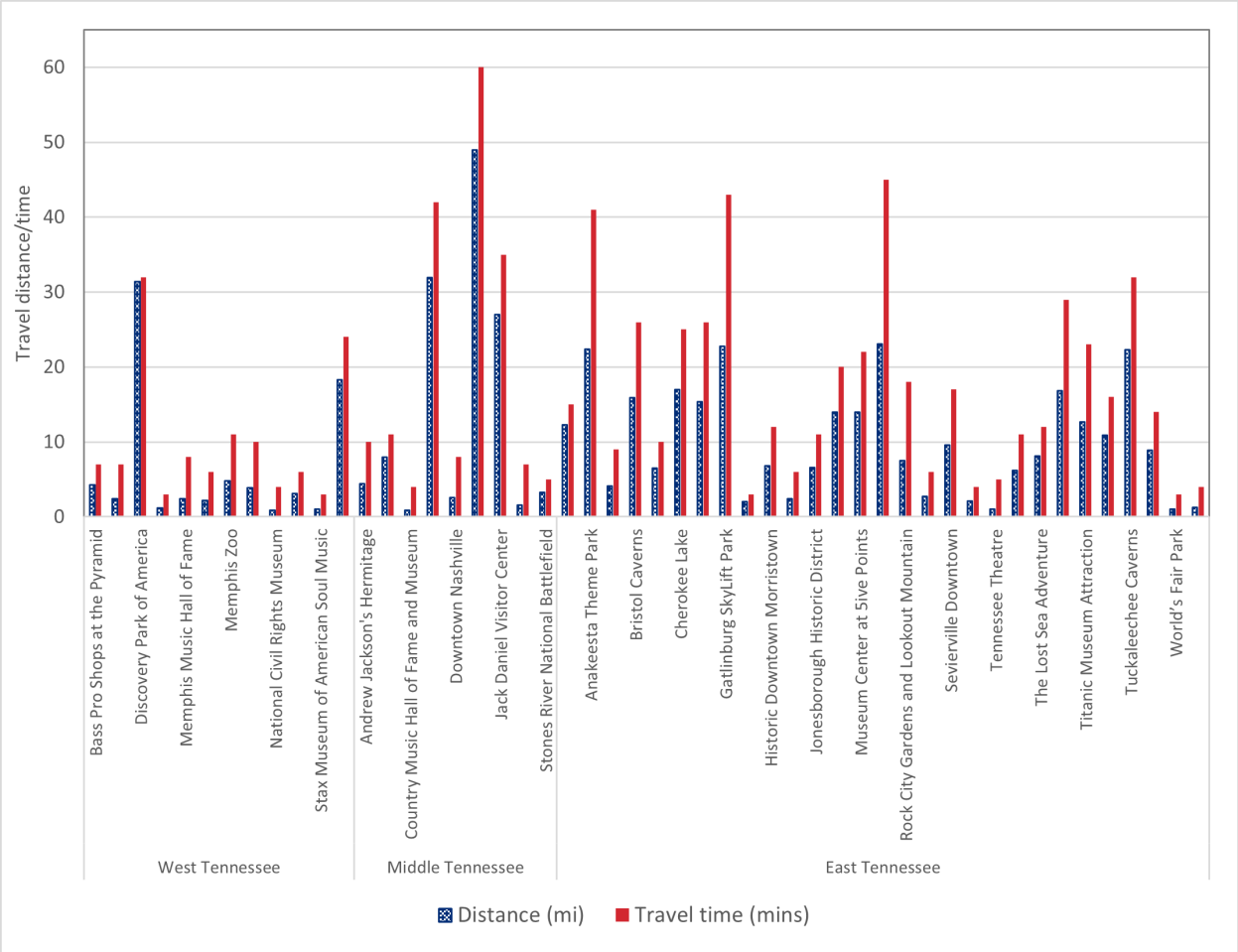


Figure 4-19 Access from nearest interstate exit

Figure 4-20 shows the distance and time taken for tourists to reach an attraction from nearest transit stop by walking. The attractions in Memphis are mostly located close to the city downtown which has good access to the transit system. While attractions in Nashville have access to transit, it takes longer to travel when riding the transit and walking. The same is observed for attractions in Pigeon Forge. Most attractions in Gatlinburg are also close to a transit stop.

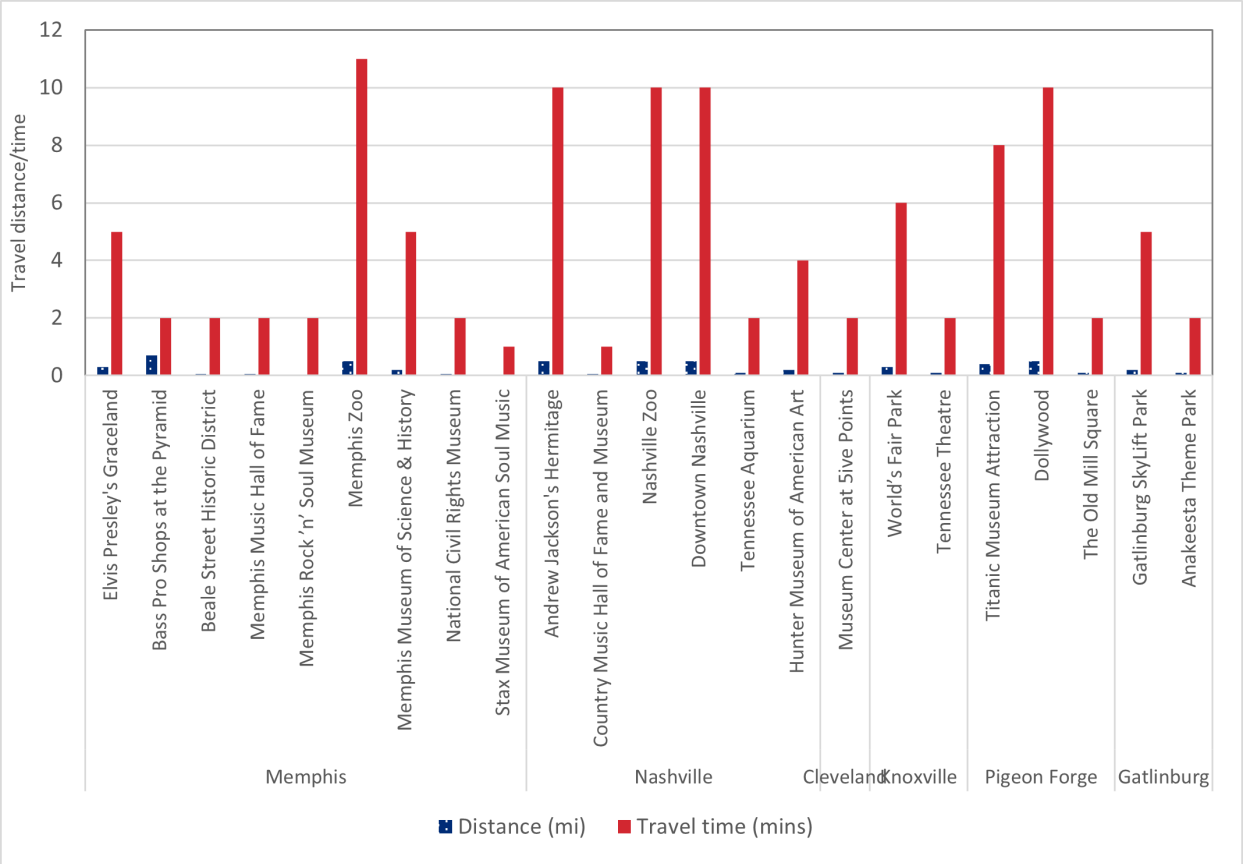
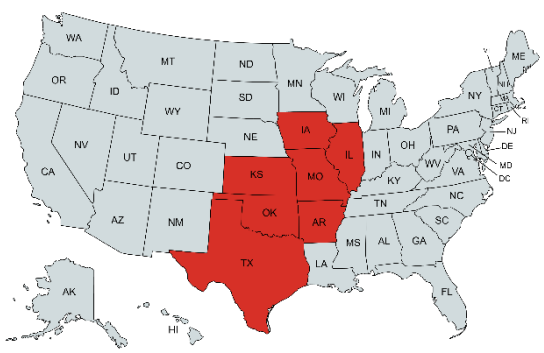


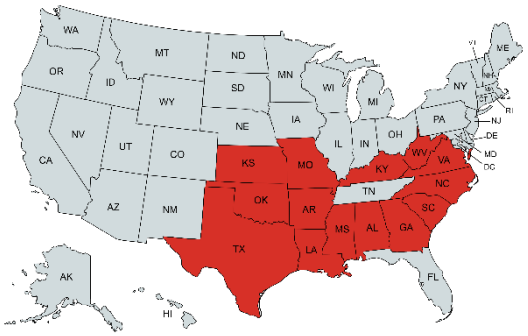
Figure 4-20 Access from nearest transit stop to the destination

4.4.2 Analysis of trips for identification of origin markets

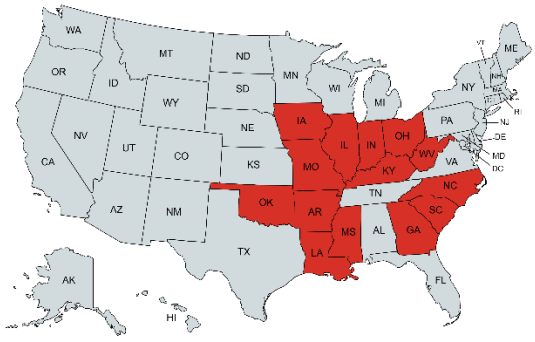
Trips counts from INRIX Trip Analytics was used to identify major tourism markets by identifying origin of long-distance trips. While INRIX Trip Analytics cannot provide actual trip volume, trips aggregated over longer periods can provide a reasonably good estimate of traffic volumes for comparison (e.g., qualitative information such as routes with more traffic, origin with more trips, etc. can be used for relative comparison since quantitative data such as the actual trip counts is not available). Notably, most of the attractions were located within Memphis, Nashville, Chattanooga, Knoxville, and Gatlinburg. The major highways used to access these cities were chosen to identify trips origins. The results from analysis of trips are included in Appendix D. The results show the interstate segments, its length and the direction of travel considered when executing data request in INRIX Trip Analytics. A summary of our findings is presented in Figure 4-21. Note that the figure highlights net trips and therefore only those states that produced more trips than it attracted are shaded.



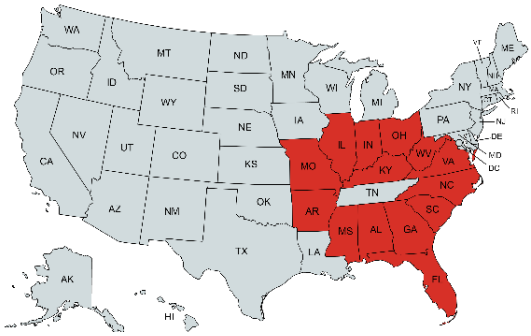
(a) Memphis



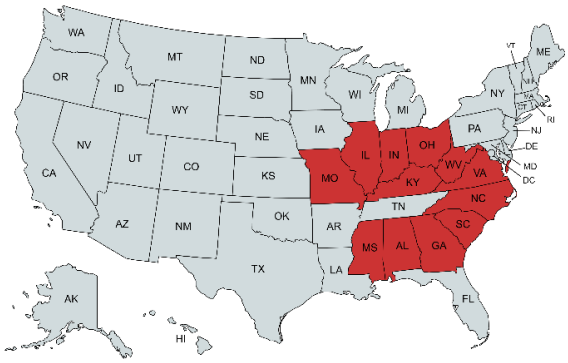
(b) Nashville



(c) Chattanooga



(d) Knoxville



(d) Gatliburg

Figure 4-21 Priority markets for tourism across Tennessee

4.4.3 Identification of popular routes

The ten intra-state O-D pairs with highest frequency trips identified using the national long distance passenger travel demand model are presented in Table 4-2 along with the route, travel distance, travel time, and Travel Time Index (TTI) for Weekday and Weekend trips. TTI is a metric used to quantify congestion based on the travel times during congestion and free flow conditions. It is calculated by dividing the average travel time by the free flow travel time. Therefore, it shows the travel times in comparison to the free flow travel times. For example, for the trips made from Hamilton to Knox County, a TTI of 1.035 suggests that during normal traffic flow conditions, the travel times are 3.5% higher than in free flow conditions. TTI values in the

table are coded using the superscripts *s*, *e,* and *g* to highlight TTI values which are smaller, equal, and greater for Weekday compared to Weekend trips, respectively.

Table 4-2 Travel Time Index for O-D pairs with most trips

Rank	Counties		Route	Length (mi)	Weekday trips			Weekend trips		
	Origin	Dest.			Travel Time (mins)	Avg Travel time (mins)	TTI	Travel Time (mins)	Avg Travel time (mins)	TTI
I	Hamilton	Knox	I 75; I 40, I 75	73.29	60.33	62.47	1.035[e]	57.93	59.93	1.035[e]
II	Knox	Hamilton	I 40, I 75; I 75	70.8	58.65	60.45	1.031[s]	56.95	58.97	1.035[g]
III	Putnam	Knox	I 40; I 40, SR 299; I 40, I 75	67.85	57.05	59.02	1.034[s]	55.93	57.95	1.036[g]
IV	Knox	Sullivan	I 40; I 81	72.08	59.00	60.62	1.027[e]	57.15	58.72	1.027[e]
V	Knox	Putnam	I 40, I 75; I 40; I 40, SR 58; I 40, SR 299	67.68	54.58	56.73	1.039[s]	53.23	55.57	1.044[g]
VI	Sullivan	Knox	I 81; I 40	72.02	57.92	59.27	1.023[s]	55.62	57.68	1.037[g]
VII	William	Knox	I 65; Four-Forty Parkway, I 440; I 24; I 40; I 40, SR 56; I 40, SR 299; I 40, I 75	165.74	142.05	146.72	1.033[g]	139.17	143.18	1.029[s]
VIII	Knox	William	I 40, I 75; I 40; I 40, SR 58; I 40, SR 299; I 40, SR 56; Four-Forty Parkway, I 440; I 65	165.78	143.80	147.73	1.027[g]	140.77	143.30	1.018[s]
IX	Knox	Unicoi	I 40; I 81; I 26, US 23; I 26, US 19W, US 23	94.26	81.53	82.20	1.008[s]	80.10	81.90	1.022[g]
X	Unicoi	Knox	I 26, US 19W, US 23; I 26, US 23; I 81; I 40	82.69	81.73	82.93	1.015[g]	84.45	84.88	1.005[s]

TTI values suggest that on routes that consist primarily of interstates, travel times are generally higher on Weekends. On the contrary, travel times on routes that include primary and secondary highways are higher on Weekdays. This suggests that traffic flow is dependent on day of the week and facility type.

4.4.4 Conclusion and implications

Assessment of travel distance and travel times to the attractions suggests that the auto travel times are proportional to the travel distance. However, attractions in Gatlinburg are an exception. Arriving at Gatlinburg takes notably longer that other attractions. We can conclude that traffic flow on the highways that lead to Gatlinburg could be improved to reduce travel time. In terms of access from transit stops, attractions in Nashville are further away from transit stops than any

other city. Understandably, agencies must deal with various constraints such as access management, land topography and availability, and travel demand when planning for transit routes and stops (e.g., (Chakraborty & Mishra, 2013; Mishra et al., 2012, 2015; Sharma et al., 2020; Sultana et al., 2018; Welch & Mishra, 2013)). Nevertheless, transit routes and stops should be planned with the objective to allow access to attractions.

Findings from analysis of trips using INRIX Trip Analytics data suggests that states bordering Tennessee are the biggest origin markets. Most trips to major attractions in Tennessee originating out of state are made from bordering states. However, it could be the case that people traveling from other states mostly use air transportation. Our findings from survey administered on tourists revealed that people are more likely to travel via air when travel distance is large (see Figure 4-5). Nevertheless, travel to attractions is dominated by auto and air travel accounts for a relatively small proportion of trips. Therefore, improvement of highway-based services should be prioritized over air transportation. Congestion on popular highway routes in the state are not of concern at present, as suggested by the small values of TTI. However, it is noteworthy that congestion on highway routes can peak during weekends and weekdays based on the type of facility. Furthermore, changes in household income and pricing policies can drastically alter mode choice and highway performance as evidenced by our findings from scenario analysis. Planners and policy makers should be wary of this.

4.5 Current state of tourism-related transportation system in Tennessee

Local tourism agencies were surveyed to gather a synopsis of current deficiencies in the transportation system and services and identify measures to address them. The results from the survey administered on local tourism agencies, mostly chambers of commerce and local tourism departments, are presented here. These results were aggregated from 33 complete responses received from the respondents.

4.5.1 Performance of available transportation systems and services

Almost half of the agencies that responded to the survey opined that the current state of transportation system and services in their area/jurisdiction was satisfactory (either moderate or good) as shown in Figure 4-22. This suggests that there is a general dissatisfaction among local agencies with the current state of transportation system.

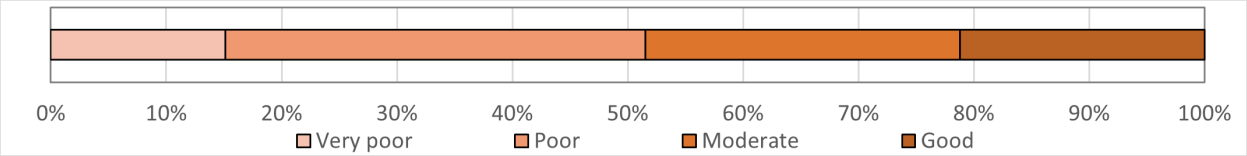


Figure 4-22 Current state of transportation systems in the area

4.5.2 Need for dedicated budget

All agencies agreed when asked if dedicated budget was necessary to develop tourism related transportation infrastructure in their area (Figure 4-23). More importantly, more than half of all respondents strongly supported the idea of allocating a dedicated budget for developing tourism transportation in their area.

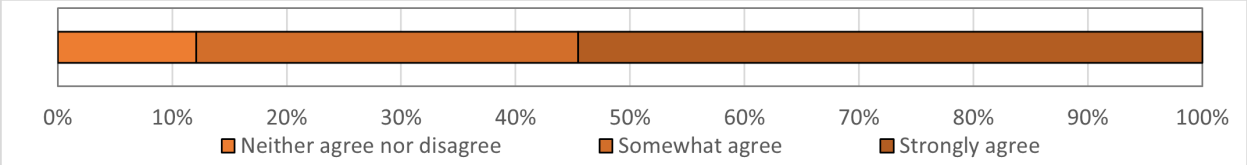


Figure 4-23 Need for dedicated budget

4.5.3 Tourism transportation planning and its role in Tennessee

The agencies' opinion of various statements associated with tourism transportation planning and its role on the economy was collected in the survey. These statements were as follows. Summary of responses collected for these statements are presented in Figure 4-24.

1. Regional tourism-related transportation services decisions should mainly be made by a committee of representatives from different stakeholders
2. Involvement of local stakeholders in tourism planning enhances sustainability of the tourism and improves the sustainability of local environment
3. Well-coordinated planning for tourism-related transportation services is critical to managing tourist volume at destinations
4. Impacts of tourism and transportation services should be integrated to the local sustainability plans
5. Tourism associated transportation services is a well-developed industry and employment sector in Tennessee
6. Transportation services play a predominant role in tourism development and community's economy
7. Tennessee has enough involvement of local communities in developing transportation services for tourism.
8. Tennessee has a well-developed plan for solving problems related to tourism transportation services.
9. The tourism sector affects local transportation services negatively and deteriorating transportation infrastructures in Tennessee.
10. The tourism sector plays a predominant role in the local economy in Tennessee.

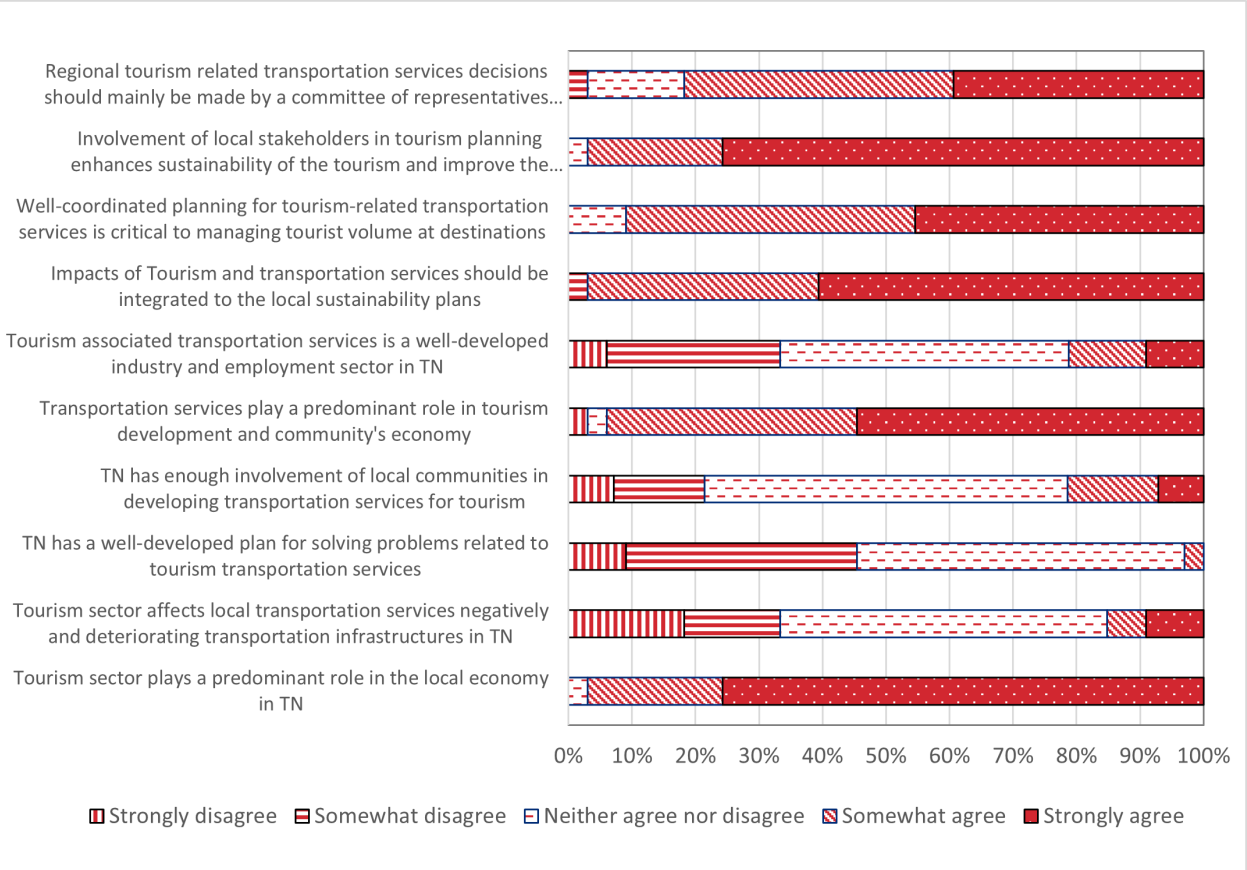


Figure 4-24 Opinions on current state of tourism related transportation services

Most agencies strongly believe that impacts of tourism should be considered when developing local sustainability plans and involvement of local stakeholders is necessary to develop tourism. According to the agencies, the tourism sector is particularly important for the local economy. On the contrary, most agencies disagree that tourism associated transportation system and services is well-developed in Tennessee.

4.5.4 Issues in transportation services

To identify current issues in transportation services, a list of issues was compiled from the literature. The survey questions collected responses by asking the agencies to specify the extent to which they agreed these issues were prevalent in their area. The resulting responses are shown in Figure 4-25. Of all the issues, inadequate transit service was most prevalent followed by a lack of comfortable services and traffic congestion on major routes.

4.5.4.1 Prevailing issues in transportation services available to tourists

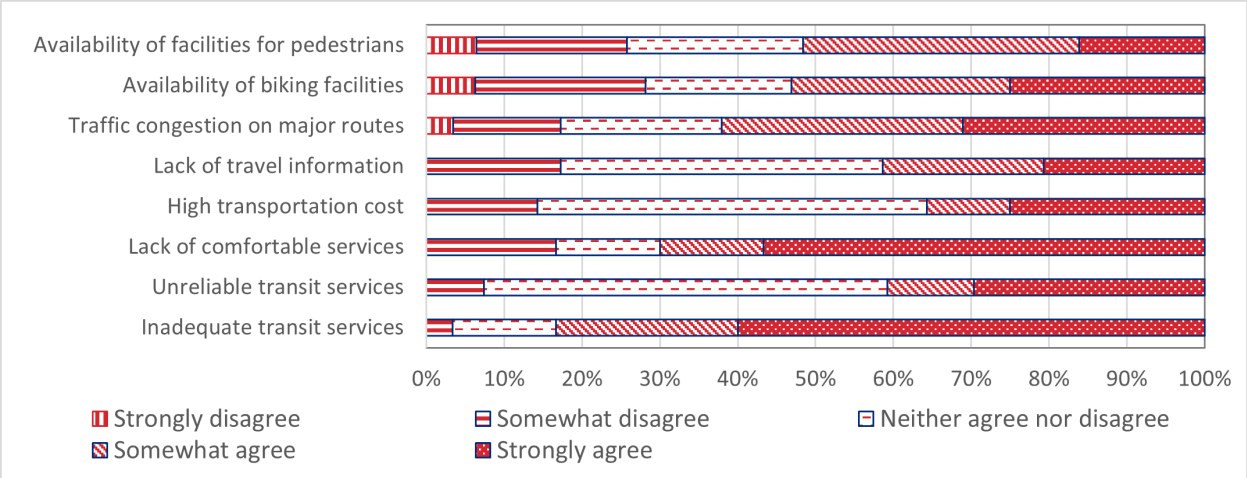


Figure 4-25 Current issues in transportation services

4.5.4.1 Solutions to address current issues in transportation services

As a follow up question to current issues in transportation services, agencies were asked to indicate potential solutions that could address the prevalent issues. The solutions that were popular were increased transit accessibility, improve highway tourism signage and establishment of interactive kiosks at high visitor traffic areas (Figure 4-26).

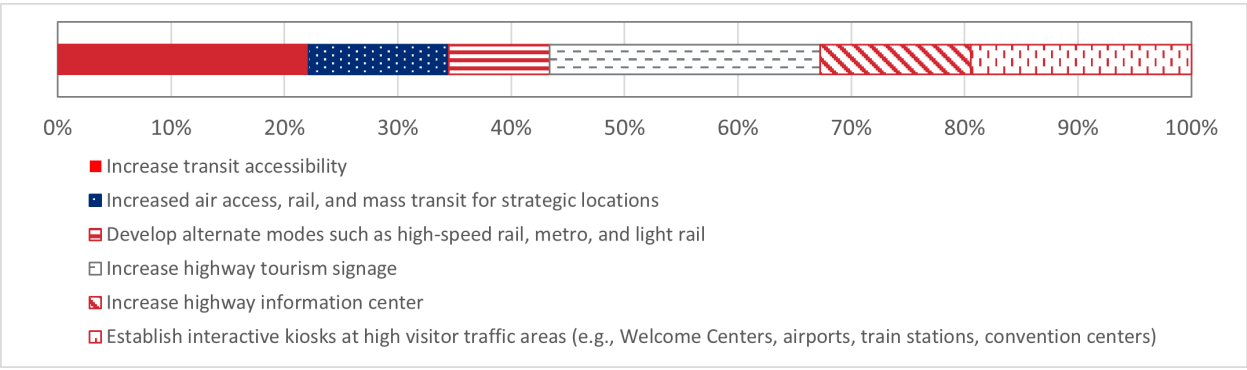


Figure 4-26 Solutions to address current issues in transportation services

Responses entered on "Others" category where respondents could add text:

1. Service from metro to destination locations in rural areas
2. Shuttle connectivity to tourism assets and attractions
3. Bicycling sharing and docking stations.

4.5.5 Ranking of initiatives to improve transportation system and services

The agencies were provided a list of initiatives that could improve transportation systems and services and were asked to rank them based on their preference with 1 being most preferred and 8 being the least preferred. The objective of this was to identify the most and least preferred initiatives from the agencies' perspective. The responses are summarized in Figure 4-27. Installing tourism signage, highway maintenance and establishing multimodal transportation infrastructure were notably the most preferred initiatives (mostly ranked 1st by the agencies).

Results also showed that availability of parking spaces and traveler information centers were of least concern to the agencies (mostly ranked 8th by the agencies).

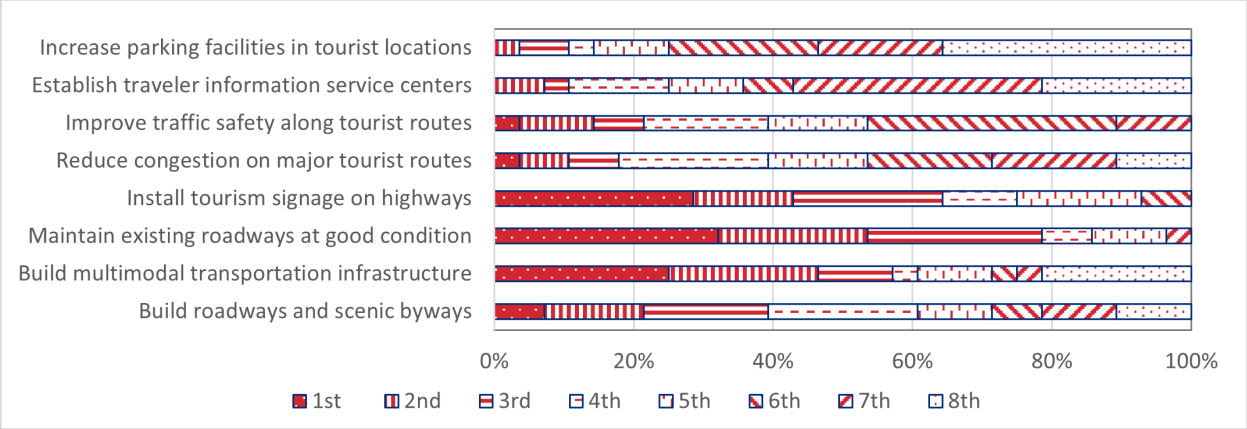


Figure 4-27 Ranking of initiatives to improve transportation system and services

4.5.6 Collaboration between agencies

There may be several obstacles in interagency collaboration. To identify them, agencies were asked to select the most prominent obstacles which were listed from the literature. The respondents could also provide their own answer as text. The agencies recognized lack of policies and legislative guidance, lack of involvement of private and public agencies and lack of willingness to cooperate between stakeholders as the biggest obstacles (Figure 4-28).

4.5.6.1 Obstacles in collaboration

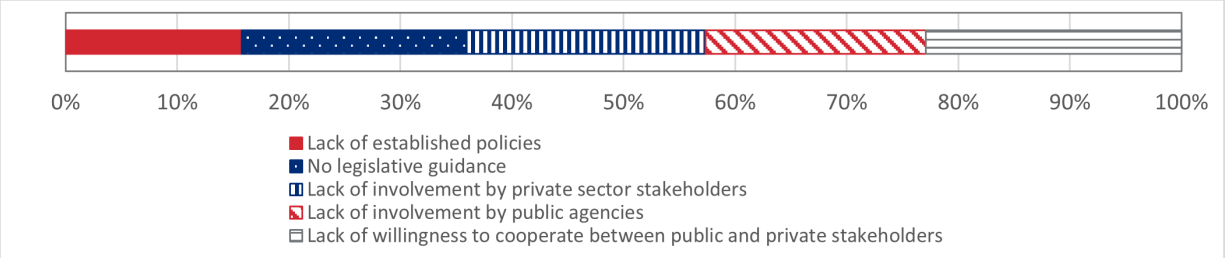


Figure 4-28 Obstacles in collaboration between agencies

Besides the listed obstacles, the agencies provided the following (entered as text). These are provided here verbatim:

1. *We are a very rural area with no public transportation of any kind.*
2. *Lack of meetings over the last several years (COVID).*
3. *lack of effort to bring groups together.*
4. *private is worried about their location and don't always take a big picture view*
5. *Lack of Funding is a major obstacle that has kept ideas from moving forward.*

4.5.6.2 Solutions and actions to foster collaboration

A follow up to the previous question focused on identifying solutions that could foster interagency collaboration. The question asked the agencies to select from enlisted options or provide their answers. Agencies indicated that establishment of policies and legislative requirement would be most helpful in fostering interagency collaboration (see Figure 4-29).

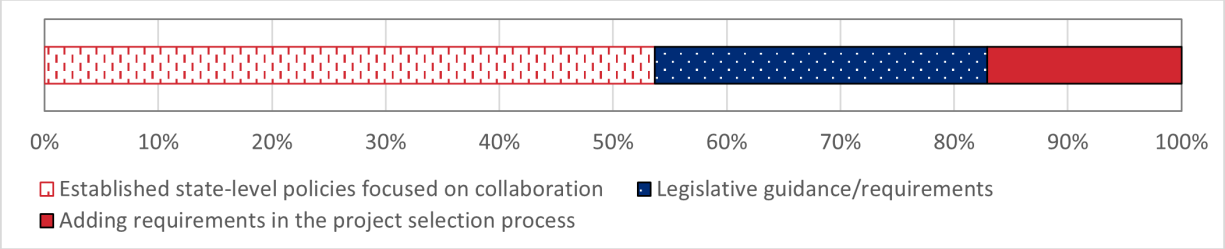


Figure 4-29 Solutions to foster collaboration between agencies

Besides the listed solutions, the agencies provided the following (entered as text). These are provided here verbatim:

1. *Better communication.*
2. *Look at proactive measures to avoid ugly and unsafe tourism from the private sector*
3. *Drinking vehicles like what has happened in Nashville at an unsafe volume. It's spreading all across Tennessee*
4. *Invite tourism to the TPO and RPO meetings for input purposes. Integrate greenway planning groups as well*
5. *Regional cooperative groups*
6. *Dedicated funding local and state*

4.5.7 Conclusion and implications

The survey revealed an overall dissatisfaction regarding tourism transportation systems among local agencies. Furthermore, agencies desire allocation of dedicated budget and better collaboration between agencies. Agencies opine that these could be remedied by state level policies and legislative guidelines. Opinions on transportation services and their role suggests that tourism related transportation is not well-developed in the state and local communities want greater involvement in planning tourism and related transportation services. In terms of current deficiencies, issues related to transit services were more prominent. The most preferred initiatives to address current transportation issues were identification and maintenance of roads and installation of tourism signage on highways.

4.6 Policy recommendations

Several concerns were identified from tasks undertaken throughout the research period. Particularly, the surveys highlighted a lack of inter-agency collaboration and need to greater involvement of state and local tourism agencies in the transportation planning process. In this section in Table 4-2, we present a list of alternatives to these issues based on common practices adopted and recommended by agencies across the county.

Table 4-2 Policy recommendations to address current concerns

Objectives	Alternatives
Increased collaboration between state DOT, tourism office, and the private sector	Establish formal guidelines and policies that necessitate interagency collaboration particularly for large transportation projects.
	Conduct regular meetings between agencies (DOTs and tourism agencies) to share information on recent projects and activities that are related to tourism and long-range planning.
Involve tourism agencies in transportation project planning	Incorporate tourism benefits and concerns in statewide transport planning, project development, and highway maintenance.
	Encourage inclusion of coordination for tourism in all aspects of DOT (such as planning, project development, construction, maintenance, etc.).
	Find additional opportunities to involve local and regional tourism stakeholders in multi-modal planning.
Collect and utilize tourism data for transportation planning	Allocate dedicated budget in transportation projects to collect tourism travel data.
	TDOT can coordinate with TDTD on travel data collection and its utilization for long-range planning.
	TDOT should collect and use relevant tourism market data in project planning.
Prioritize transportation system improvement	Consider new ways to prioritize projects in addition to the current practice.
	Give tourism due consideration in the statewide transportation plan.
	Establish principles that guide prioritization of transportation system/services that needs improvement.
	Involve local and regional tourism stakeholders in the decision process when prioritizing transportation projects.
Increase involvement of local agencies	Provide additional opportunities for local agencies to improve transportation system and services at local level, for example, through additional funds and grants.
	Increase participation of tourism businesses and organizations in transportation project planning and execution through involvement opportunities and dissemination of updates on current and future projects.

Chapter 5 Conclusion

The tourism industry is a major source of revenue for Tennessee. Historical and natural destinations in the state attract increasing number of visitors every year. There is a need for an efficient and sustainable transportation system capable of supporting visitors traveling to tourist destinations. The current state of transportation system is of concern considering that major cities in the state, Memphis, Nashville, Knoxville, Cleveland, and Chattanooga, are among the most congested cities in the US. These cities are home to some of the most popular destinations in the state. The goal of this study was to provide Tennessee Department of Transportation with policy recommendations to improve transportation services dedicated to tourists.

This research surveyed state DOTs and STOs across the country to understand state specific tourism related travel demand modeling practices, tourism data sources, and data analysis methods, tourism inclusive project selection practices, consideration of sustainable transportation for tourism, and collaboration manner between diverse tourism stakeholders. The survey responses were analyzed using *k*-means clustering technique and three clusters were identified: states with low, medium, and high tourism impacts. The results showed that states with greater interagency collaboration was associated with higher tourism impact. Agencies identified lack of budget and inter-agency collaboration as the primary obstacles to developing sustainable tourism transportation system.

Tourists who had traveled to recreational destinations in Tennessee were also surveyed to gather information on long-distance trip characteristics such as socio-demographics and household characteristics of tourists, mode choice, and attitude towards travel particularly considering the COVID-19 pandemic. The survey responses were analyzed using TPB and NCA to identify predictors of travel intentions and its necessary predictors. Results showed that travel incentives such as flexible booking and cancellations, and better dissemination of information related to the pandemic were necessary to manifest travel intentions and encourage people to travel more.

In the next step, a scenario-based analysis was undertaken using the national long-distance passenger travel demand model. The analysis assumed four scenarios to forecast potential changes in tourism travel. These scenarios were: improve transit access, reduced air fare, reduced congestion on popular tourist routes, and increase in household income. Improvement in any of these conditions predicted an increase in tourist travel. For example, with a 30% reduction in air fare, personal car trips can be expected to reduce by about 1.3%, similarly, with a 30% increase in household income, about 0.93% increase in leisure trips can be expected. Using the long-distance model, O-Ds within the state with the most trips were also identified.

The most popular attractions in the state were identified to assess their accessibility. Travel time and travel distance to these attractions from nearest urban areas, primary commercial airport, interstate exit, and transit stop were obtained using Google Maps and GTFS data. Analysis showed that it took disproportionately longer time (compared to distance) to reach Gatlinburg from the nearest interstate exit. This suggests that the tourist routes used to travel to Gatlinburg needs improvement. Similarly, among cities with transit facilities, travel times from the nearest transit stop to the attractions was higher for Nashville. This finding points to inadequate transit facilities available to tourists in Nashville. Analysis of trips made to these destinations was also done using INRIX Trip Analytics to identify origin markets. State that produced more trips than

they attracted were identified for major tourist area: Memphis, Nashville, Chattanooga, Knoxville, and Gatlinburg.

Finally, a survey was administered on local agencies involved with tourism to get an understanding of current state of transportation system in their area, its deficiencies, and initiatives to address them. Local and regional chambers of commerce and tourist offices were participants in the survey. The major findings of the survey were, (i) need of dedicated budget to develop and maintain tourism transportation system/services, and (ii) encouraging interagency collaboration through formal standards/guidelines. Also, for currently available transportation service, problems related to transit services (inadequate and uncomfortable service) was identified as the most prominent issue faced by agencies at the local level. The agencies ranked maintenance of highways and installation of tourism signages as most preferred initiatives to fix current deficiencies in transportation system.

Recommendations

Transportation systems play a significant role in tourism development by connecting tourism-generating regions to destinations. The distribution, capacity, efficiency, and accessibility of transport services can affect how a destination develops, visitors' mobility, and the connectivity of tourist experiences within destinations. However, an increased number of tourists can create challenges in terms of the sustainability of the tourism transportation system. Thus, proper planning and policy development are necessary to maintain the sustainability of the transportation system and destinations. This section presents policy and guidelines for sustainable tourism transportation services.

1. Both previous literature and surveys conducted in this study indicated a lack of effective collaboration among the tourism stakeholders. This barrier can be removed by improving collaboration between tourism stakeholders in project development and implementation. TDOT, state tourism offices and tourism agencies can collaborate by exchanging available resources, and involving in the project development, selection, and implementation process. Moreover, the resources that need better partnership pertain to tourism data collection and its utilization. While TDOT is already involved in roadway infrastructure development related to tourism, such as signage, rest areas, scenic turnouts, and scenic byways, we recommend prioritizing such development based on tourism associated benefits.
2. To promote sustainability of the tourism transportation services, sustainable modes of transportation and services should be developed and promoted. Cycling is becoming a popular mode of transportation for its environmental and health benefits. States can use this potential to develop policies to promote “cycling tourism”. These policies could include construction of ‘scenic greenways’, bicycle lanes, park and ride, and bike-sharing services. Attractions in Memphis, Nashville, Knoxville, Cleveland, and Chattanooga, which are congested with limited transit access, can benefit the most from such initiatives.
3. Engagement of the private sector in tourism transportation service planning and development must be increased through collaboration. The private sector can play a key role in tourism-related transportation planning. The principal areas for private sector collaboration with the DOT and state tourism offices are private sector funding, marketing, data collection, and dissemination of tourism information.

4. Use of data-driven practices for project selection should be encouraged. Most state DOTs and tourism agencies do not collect tourist Origin-Destination data. They also mentioned the high cost of third-party data. In this regard, more innovative approaches to data collection can be identified through inter-agency collaboration.
5. A more detailed analysis of current state of transportation infrastructure in popular tourist areas and routes is warranted particularly in Nashville, Gatlinburg, and Pigeon Forge to identify and remedy current deficiencies. More tourists can be attracted to these destinations if cheaper alternative to car and better public transportation is available. Considering substantial number of tourists travel to Tennessee from the neighboring states, routes that connect major destinations to bordering stats should be prioritized for future development and regular maintenance.

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Appendices

Appendix A: Survey of state DOTs and tourism agencies

A.1 Summary of the data and survey questions

Search engine data related to tourism travel was collected from the Google trend website for the year 2019. The tourism travel economic impact data were collected from the US travel Association website. These collected variables were used for the clustering process. The summary statistics of the collected dependent and independent variables are shown in Table A-1.

Table A-1 Summary statistics of collected variables

Variable	Mean	SD	Min	Max
Total spent by domestic and international travelers (billion)	22.99	29.01	2.50	159.30
Tourism Travel-supported job (Thousands)	177.120	215.89	17.34	1066.11
Tax Receipts from Tourism Travel (in billion)	3.31	4.32	0.29	22.20
Population Density (Per Square Mile)	404.39	1478.24	1.27	10700.08
Search Engine Data (0-100)*				
Airbnb	57.80	14.21	34	100
Air tickets	62.33	13.87	38	100
Airline tickets	54.22	15.00	30	100
Airports	56.78	11.13	39	100
Booking.com	58.98	17.96	28	100
Bus ticket	56.62	14.95	25	100
Car rental	38.06	12.40	21	100
Flights	59.84	13.57	35	100
Food	81.25	8.09	68	100
Fun places	67.90	17.21	29	100
Google flights	28.53	14.69	9	100
Historic site	31.80	13.56	14	100
Hotel booking	42.90	15.87	11	100
Hotels	66.35	9.53	55	100
National parks	34.08	16.69	18	100
Night life	46.37	12.00	14	100
Recreational	36.27	17.04	19	100
Rent a car	24.86	13.50	13	100
Resort	52.76	14.47	32	100
Restaurant	66.45	13.94	42	100
Rest areas	32.11	17.69	12	100
Shuttle bus	31.16	20.43	3	100
Travel agency	59.75	12.81	34	100
Travel	62.51	12.24	45	100
TripAdvisor	42.19	14.23	23	100

* A value of 100 means highest popularity and 0 indicates that there was insufficient data for the keyword

A.2 Summary of the Survey

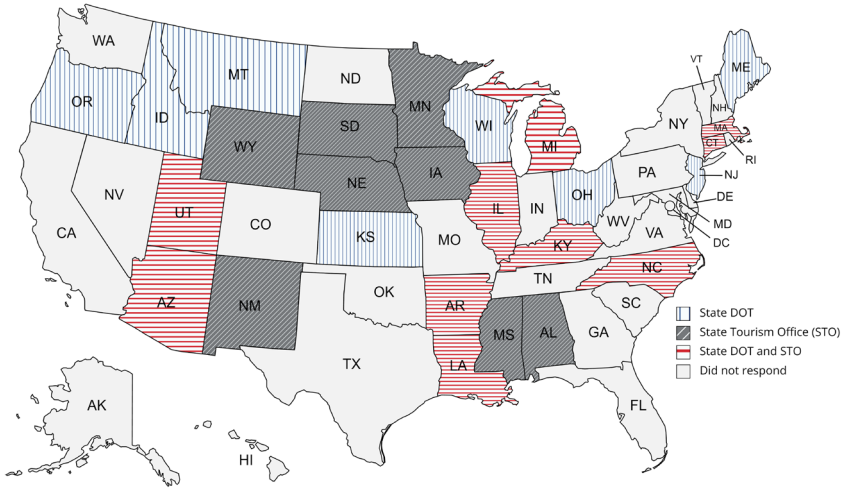


Figure A-1 Map of the survey respondents by state and agency types

A total of 33 complete and 6 partially complete (about 50%-80% complete) responses were received from DOTs and STOs. A map of the states that participated in the survey is shown in Figure A-1. The responding states were well distributed all over the U.S. Six states from the West region, nine states from the Midwest region, two states from the Southwest region, six states from the Southeast region, and four states from the Northeast region responded to the survey. Data for the rest of the states were synthesized after the clustering process to create a complete picture of the current practices and policies and tourism-related transportation infrastructure and services. A summary of the survey questions that were used to compare different tourism travel characteristics of the state clusters is presented in Table A-2.

Table A-2 Summary of response obtained from the survey

Question	**n**	**%**	**Question**	**n**	**%**
State DOT respondents			**State Tourism Stakeholders**		
Performance Measures					
Yes	5	19.23	*Yes*	1	5.56
No	13	50	*No*	14	77.78
Not Sure	8	30.77	*Not Sure*	3	16.67
Collaboration with State Tourism Office			Collaboration with State DOTs		
Always	1	4.55	*Always*	1	5.88
Usually	10	45.45	*Usually*	2	11.76
About Half of the Time	3	13.64	*About Half of the Time*	1	5.88
Seldom	7	31.82	*Seldom*	12	70.59
Never	1	4.55	*Never*	1	5.88
Collaboration with Neighboring State Tourism Stakeholders					
Always	0	0	*Always*	0	0
Usually	4	18.18	*Usually*	0	0

Question State DOT respondents	n	%	Question State Tourism Stakeholders	n	%
About Half of the Time	5	22.73	*About Half of the Time*	0	0
Seldom	10	45.45	*Seldom*	9	52.94
Never	3	13.64	*Never*	8	47.06
Collaboration with private sector stakeholders					
Always	4	19.05	*Always*	0	0
Usually	9	42.86	*Usually*	1	6.67
About Half of the Time	3	14.29	*About Half of the Time*	2	13.33
Seldom	5	23.81	*Seldom*	12	80
Never	0	0	*Never*	0	0
Collection of tourism trip-related data					
Yes	7	29.17	*Yes*	6	40
No	7	19.17	*No*	8	53.33
Not Sure	10	41.67	*Not Sure*	1	6.67
Collection of Emerging Dataset					
Yes	10	43.48	*Yes*	6	40
No	8	34.78	*No*	7	46.67
Not Sure	5	21.74	*Not Sure*	2	13.33
Tourism Forecasting					
Yes	3	16.67	*Yes*	5	33.33
No	10	55.56	*No*	10	66.67
Not Sure	5	27.78	*Not Sure*	0	0

A.3 *k*-means Clustering Results

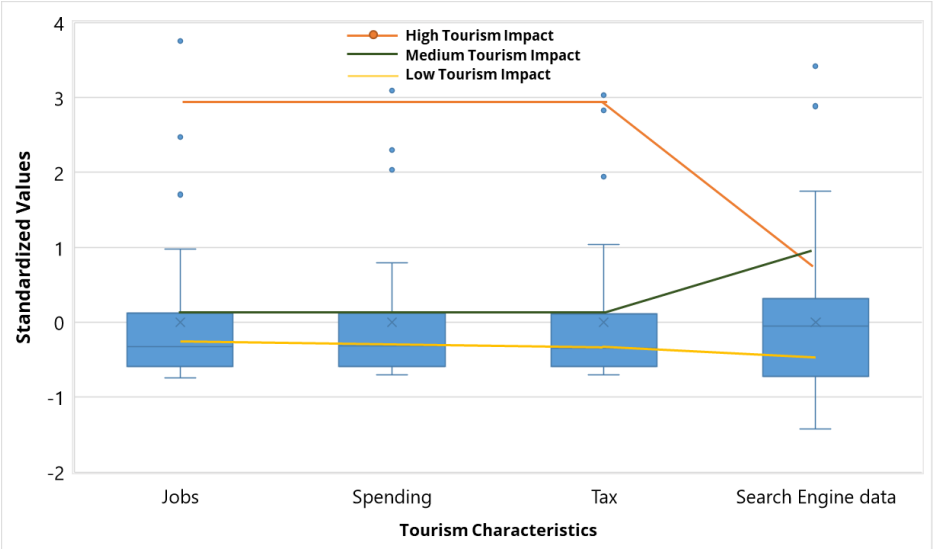


Figure A-2 Multivariate clustering boxplot for identified state clusters

For the clustering process, four variables were used—total spending by the domestic and international travelers, tourism travel supported jobs, tax receipts from tourism travel (in billion),

and the total score of the tourism-related keywords appearing in the search engine. Multivariate clustering boxplots for the three clusters are shown in Figure A-2 and the three clusters of states are shown in Figure A-3. Four states in Cluster 1 are California, Florida, New York, and Texas. These states had a higher impact of tourism travel on their state's economy. On the other hand, Cluster 2 (medium tourism impact cluster), had above-average values for tourism travel supported jobs, spending by domestic and international travelers, tax collected from the tourism sector, and tourism travel characteristics. There are 15 states in this cluster with a medium impact of tourism on the state's economy. Lastly, cluster 3 (low tourism impact cluster) states had an average performance in terms of tourism travel supported jobs, spending by domestic and international travelers, and tax collected from the tourism sector.

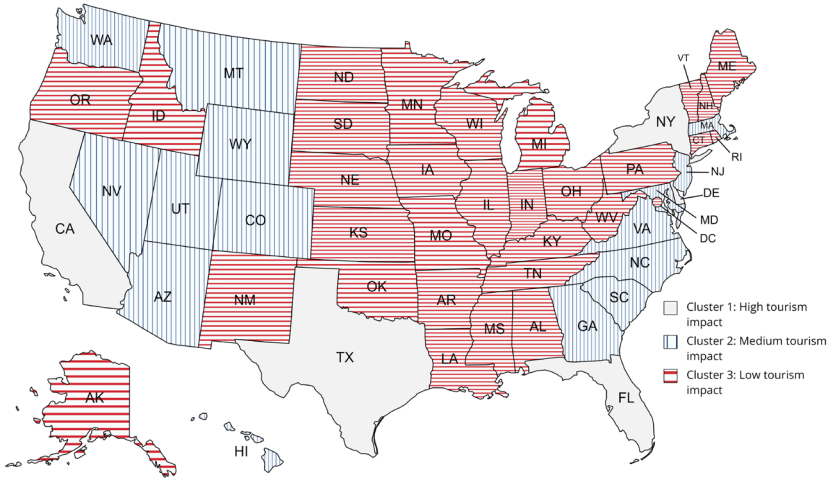


Figure A-3 Map showing clusters of states based on tourism travel characteristics

A.4 Discussion: Cluster analysis

Transportation planners may include tourism into travel demand forecasting, planning, prioritizing, and design processes by using tourism-related travel data. The types of tourism travel data, their intended use, limitations of available data, and requirement of additional data should be identified to develop a data-driven tourism-related transportation planning. The specific types of tourism-related transportation system and service data that are frequently collected by the agencies include tourist O-D trip data, tourist activity data (routes and modes used, time spent, trip chaining etc.), and trade survey data. However, long-distance tourism trips have not been an integral part of the regional travel demand model. In the survey, state DOTs and STOs were asked about their tourism travel data collection practices, their modeling techniques for tourism travel forecasting, limitations of tourism travel data, and types of emerging datasets they collect for planning purposes. Aggregated result of the survey of two clusters is shown in Figure A-4. Responses showed that 40% (6 out of 15 states) of the state DOTs and STOs collect tourism-related data for tourism-related transportation planning, transportation infrastructure and service developments, and associated investment decision-making among states with medium tourism impact (Figure 6). Among states with low tourism impact, only 28% of the states (9 out of 32) collect tourism travel-related data for planning purposes. Also, the collection of emerging tourism travel datasets (e.g., Global Positioning System (GPS) data, cell phone data) was more frequent (56% of 15 states) among states with medium tourism impacts compared to low tourism impact states (29% of 32 states). In terms of tourism

travel forecast, 42% of the state DOTs with medium tourism impact and 28% of the state DOTs with low tourism impact forecast tourism or tourism travel in their states. Although the practice of tourism travel forecast is not common among both medium and low tourism impact states, a higher percentage of states with medium tourism impact used tourism travel forecasting methods compared to low tourism impact states. The above discussion indicates that the inclusion of data into tourism transportation planning is still not common among low tourism impact states.

The emergence of new data sources such as cell phone data, GPS data, and social media data has changed how data can be used in tourism transportation planning. According to survey respondents, the most frequently collected emerging dataset by tourism and transportation departments was cell phone data. State DOTs and tourism agencies also collected Tourist O-D and activity data for the planning purpose. In terms of tourism data collection issues, most of the state DOTs expressed that the cost of acquiring data from private companies and lack of data collection standards are the two key issues associated with tourism data collection and quality. State tourism agencies also mentioned that cost of data collection is the main issue in acquiring tourism data. However, they also said that limitations in data collection methods (e.g., excessive cost) and inconsistencies in data collection (e.g., discrepancies among data sources) are the other two most frequent issues associated with tourism data quality. In conclusion, tourism data collection methods and data acquisition costs need to be addressed to ensure consistency in data use among states and agencies.

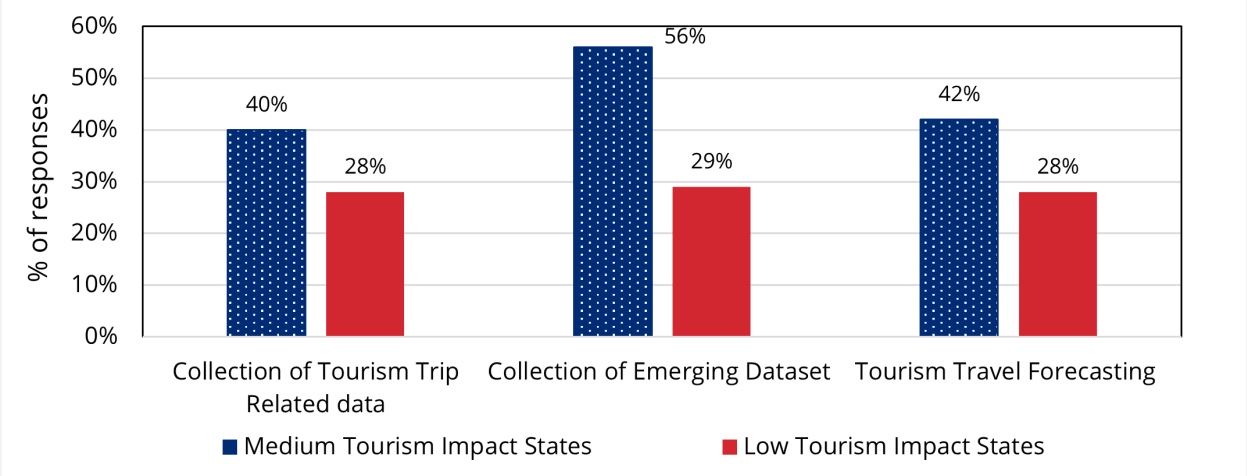
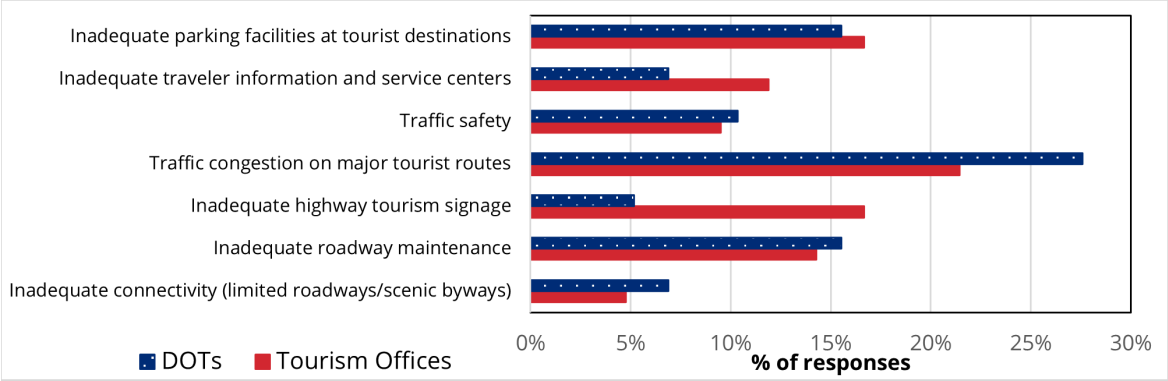


Figure A-4 Cluster-wise distribution of tourism data collection and forecasting practices

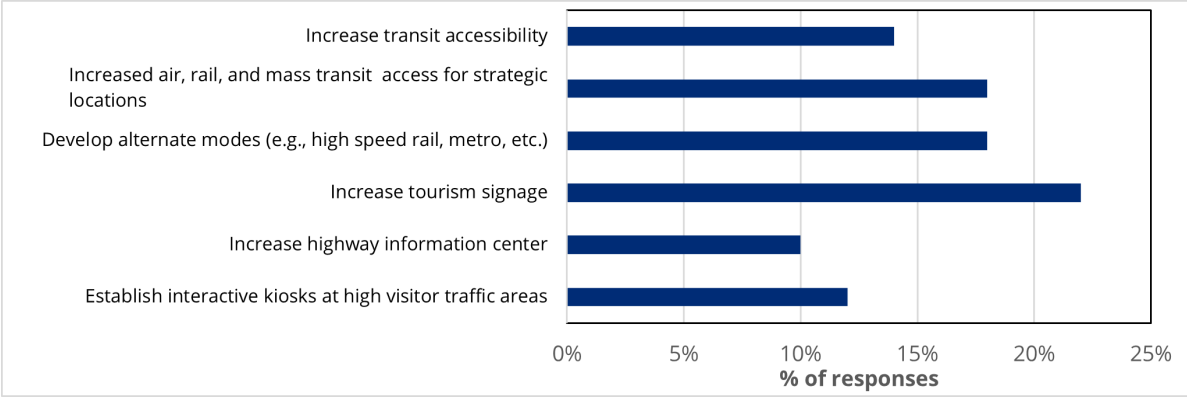
A.5 Discussion: Deficiencies of tourism transportation services

In the survey, responding agencies identified the existing tourism transportation services, the limitations of the current transportation services in supporting tourism, and how to overcome the limitations. Most of respondents reported that their respective states had developed tourism-focused road signage and maps in recent years. Some of the states have developed park and ride facilities at transit stops. According to the survey responses, the most common type of tourism-related transportation infrastructure was highway rest areas and welcome centers. Inadequate parking facilities at popular tourist destinations are one of the limitations of tourism transportation services (Figure A-5(a)). The figure also shows that almost 28% of the state DOTs

and 22% of the STOs mentioned traffic congestion on major tourism routes as a primary concern. Apart from that, inadequate tourism signage, tourism-related information, and roadway maintenance were also mentioned by some agencies. Higher transit access to tourist destinations was considered critical in improving the sustainability of tourism (Figure A-5(b)). Almost 18% of the tourism departments mentioned that developing alternate modes such as high-speed rail, metro, and light rail was necessary to solve the current challenges in developing tourism-related transportation services (Figure A-5(b)). Furthermore, 18% of the tourism departments mentioned that higher air, rail, and mass transit access for strategic tourism locations are needed for sustainable tourism transportation services (Figure A-5(b)). Initiatives promoting active modes of transportation (e.g., bicycles and walking) are becoming popular all over the U.S., and these modes are also important for first and last-mile connectivity to tourist destinations. In the survey, almost 70% of the DOTs mentioned that they consider first and last-mile transportation services in the project planning process. The survey result showed that the most common initiatives taken by the DOTs to make these two modes more popular include the establishment of bike lanes and bike routes, sidewalk, and improvement of the pedestrian facility, park and ride facilities at transit stops, establishing bike racks in buses, and introduction of bike-sharing services.



(a) Limitations of current tourism transportation services



(b) Potential solution for solving tourism related transportation problems

Figure A-5 Summary of responses on current deficiencies and its solutions

Appendix B: Result from analysis of travel intentions

B.1 Results from SEM analysis

Table B-1 Descriptive statistics of participants' response to attitudinal questions

Construct	Indicator	Mean (SD)	Source	Factor loading
Public trust **(α=0.78)**	I trust the information provided by public health agencies on the pandemic.	3.41 (1.19)	Own scale	0.56
	I am confident that the spread of COVID-19 will be controlled sooner than later.	3.60 (1.07)		0.41
	I believe public health measures such as mandatory use of face coverings and social distancing are useful in controlling the spread of COVID-19.	3.73 (1.27)		0.60
Subjective norm **(α=0.88)**	I believe that COVID-19 vaccines will protect me from the virus.	3.66 (1.21)	Han et al. (2020)	0.65
	Most people who are important to me would travel for recreational purposes regardless of the ongoing pandemic.	3.09 (1.31)		0.68
	Most people who are important to me think I should travel to tourist destinations regardless of the risks from the virus.	2.83 (1.31)		0.76
	People whose opinions I value would think it appropriate for me to travel to tourist destinations despite the pandemic.	2.93 (1.32)		0.75
Attitude **(α=0.88)**	Traveling to a destination that is not seriously affected by the COVID-19 outbreak for my next vacation trip is bad.	3.84 (1.27)	Han et al. (2020)	0.79
	Traveling to a destination that is not seriously affected by the COVID-19 outbreak for my next vacation trip is unpleasant.	3.88 (1.19)		0.81
	Traveling to a destination that is not seriously affected by the COVID-19 outbreak for my next vacation trip is foolish.	3.89 (1.25)		0.74
	Whether I travel to a tourist destination that is not seriously affected by the COVID-19 outbreak is entirely up to me.	3.93 (1.12)		0.51

Construct	Indicator	Mean (SD)	Source	Factor loading
Perceived behavioral control **(α=0.76)**	I am confident that I can travel to a tourist destination that is not seriously affected by the COVID-19 outbreak if I want to.	3.71 (1.17)		0.68
	I have sufficient resources, time, and opportunities to visit a tourist destination that is not seriously affected by the COVID-19 outbreak.	3.65 (1.17)		0.61
Travel composure **(α=0.88)**	I am comfortable driving to a destination on my vehicle.	3.99 (1.21)	Stansbury et al., (2020)	0.69
	I am comfortable taking a flight.	3.01 (1.38)		0.71
	I am comfortable renting a car.	3.32 (1.28)		0.64
	I am comfortable using a ride share service (e.g., Uber or Lyft).	2.73 (1.35)		0.77
	I am comfortable using public transport (transit bus, train, or the metro).	2.57 (1.35)		0.75
Travel anxiety **(α=0.9)**	COVID-19 makes me worry a lot about my normal ways of traveling.	3.93 (1.27)	Zenker et al. (2021)	0.75
	It makes me uncomfortable to think about COVID-19 while planning my vacation.	3.32 (1.28)		0.79
	When watching the news about COVID-19, I become nervous or anxious regarding travel.	3.34 (1.31)		0.78
	I do not feel safe traveling due to COVID-19.	3.17 (1.35)		0.74
Travel concern **(α=0.86)**	I am concerned about the health of my family members, friends, and relatives during the pandemic	2.43 (1.35)	Own scale	0.54
	I am concerned about being quarantined away from home during my travels due to COVID-19	2.87 (1.48)		0.79
	I am concerned about travel restrictions on the way and at the destination after I have started traveling	2.82 (1.41)		0.88
	I am concerned about travel cost from sudden cancellations (e.g., cancellation of tickets, lodging, etc. without refund)	2.91 (1.43)		0.73

Construct	Indicator	Mean (SD)	Source	Factor loading
Perceived knowledge **(α=0.85)**	Compared with the average person, I know the facts about COVID-19.	3.78 (0.96)	Han et al. (2020)	0.75
	Compared with my friends, I know the facts about COVID-19.	3.76 (0.94)		0.80
	Compared with people who travel frequently, I know the facts about COVID-19.	3.67 (0.99)		0.76
Perceived benefits **(α=0.89)**	I would travel to a destination if the cost of travel is reduced.	3.34 (1.20)	Own scale	0.81
	I would travel to a destination if the cost of travel insurance is reduced.	3.17 (1.19)		0.73
	I would travel to a destination if the cost of dining, lodging, or services is reduced.	3.40 (1.20)		0.82
	I would travel to a destination if it were not crowded.	3.71 (1.12)		0.61
Behavioral intention **(α=0.80)**	Whenever I have a chance to travel, I will.	3.32 (1.25)	Zenker et al. (2021)	0.56
	I will do my best to improve my ability to travel.	3.34 (1.07)		0.76
	I will keep on gathering travel-related information in the future.	3.18 (1.05)		0.55

Note: The responses were collected on a 5-point Likert scale with 1-strongly disagree to 5-strongly agree.

Table B-2 Results from factor analysis

Construct	Item	Mean (SD)	Source	Factor loading
Public trust **(α=0.78)**	I trust the information provided by public health agencies on the pandemic.	3.41 (1.19)	Own scale	0.56
	I am confident that the spread of COVID-19 will be controlled sooner than later.	3.60 (1.07)		0.41
	I believe public health measures such as mandatory use of face coverings and social distancing are useful in controlling the spread of COVID-19.	3.73 (1.27)		0.60
	I believe that COVID-19 vaccines will protect me from the virus.	3.66 (1.21)		0.65
Subjective norm **(α=0.88)**	Most people who are important to me would travel for recreational purposes regardless of the ongoing pandemic.	3.09 (1.31)	Han et al. (2020)	0.68
	Most people who are important to me think I should travel to tourist destinations regardless of the risks from the virus.	2.83 (1.31)		0.76
	People whose opinions I value would think it appropriate for me to travel to tourist destinations despite the pandemic.	2.93 (1.32)		0.75
Attitude **(α=0.88)**	Traveling to a destination that is not seriously affected by the COVID-19 outbreak for my next vacation trip is bad.	3.84 (1.27)	Han et al. (2020)	0.79
	Traveling to a destination that is not seriously affected by the COVID-19 outbreak for my next vacation trip is unpleasant.	3.88 (1.19)		0.81
	Traveling to a destination that is not seriously affected by the COVID-19 outbreak for my next vacation trip is foolish.	3.89 (1.25)		0.74
Perceived behavioral control **(α=0.76)**	Whether I travel to a tourist destination that is not seriously affected by the COVID-19 outbreak is entirely up to me.	3.93 (1.12)	Han et al. (2020)	0.51
	I am confident that I can travel to a tourist destination that is not seriously affected by the COVID-19 outbreak if I want to.	3.71 (1.17)		0.68
	I have sufficient resources, time, and opportunities to visit a tourist destination that is not seriously affected by the COVID-19 outbreak.	3.65 (1.17)		0.61

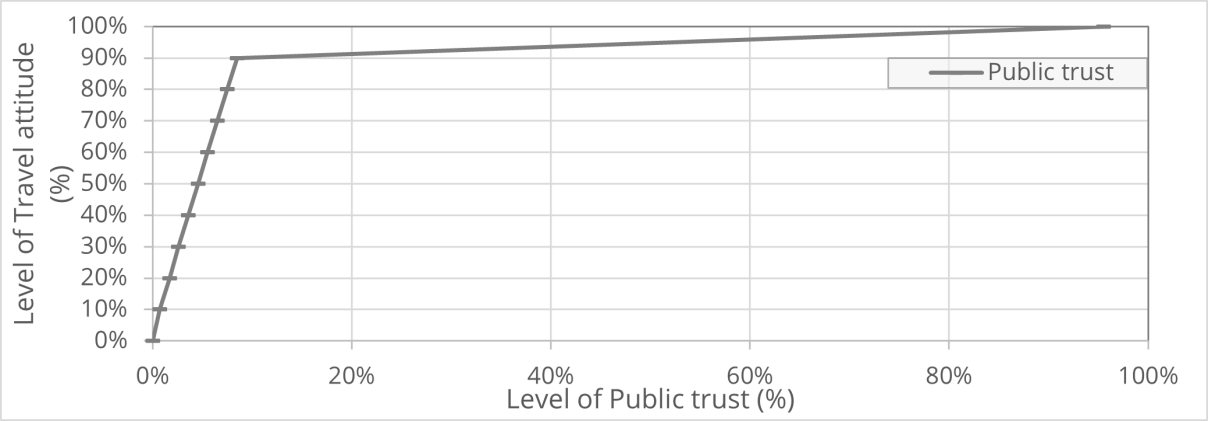
Construct	Item	Mean (SD)	Source	Factor loading
Travel composure **(α=0.88)**	I am comfortable driving to a destination on my vehicle.	3.99 (1.21)	Stansbury et al., (2020)	0.69
	I am comfortable taking a flight.	3.01 (1.38)		0.71
	I am comfortable renting a car.	3.32 (1.28)		0.64
	I am comfortable using a ride share service (e.g., Uber or Lyft).	2.73 (1.35)		0.77
	I am comfortable using public transport (transit bus, train, or the metro).	2.57 (1.35)		0.75
Travel anxiety **(α=0.9)**	COVID-19 makes me worry a lot about my normal ways of traveling.	3.93 (1.27)	Zenker et al. (2021)	0.75
	It makes me uncomfortable to think about COVID-19 while planning my vacation.	3.32 (1.28)		0.79
	When watching the news about COVID-19, I become nervous or anxious regarding travel.	3.34 (1.31)		0.78
	I do not feel safe traveling due to COVID-19.	3.17 (1.35)		0.74
Travel concern **(α=0.86)**	I am concerned about the health of my family members, friends, and relatives during the pandemic	2.43 (1.35)	Own scale	0.54
	I am concerned about being quarantined away from home during my travels due to COVID-19	2.87 (1.48)		0.79
	I am concerned about travel restrictions on the way and at the destination after I have started traveling	2.82 (1.41)		0.88
	I am concerned about travel cost from sudden cancellations (e.g., cancellation of tickets, lodging, etc. without refund)	2.91 (1.43)		0.73
Perceived knowledge **(α=0.85)**	Compared with the average person, I know the facts about COVID-19.	3.78 (0.96)	Han et al. (2020)	0.75
	Compared with my friends, I know the facts about COVID-19.	3.76 (0.94)		0.80
	Compared with people who travel frequently, I know the facts about COVID-19.	3.67 (0.99)		0.76
	I would travel to a destination if the cost of travel is reduced.	3.34 (1.20)		0.81

Construct	Item	Mean (SD)	Source	Factor loading
Perceived benefits	I would travel to a destination if the cost of travel insurance is reduced.	3.17 (1.19)	Own scale	0.73
	I would travel to a destination if the cost of dining, lodging, or services is reduced.	3.40 (1.20)		0.82
(α=0.89)	I would travel to a destination if it were not crowded.	3.71 (1.12)		0.61
Behavioral intention	Whenever I have a chance to travel, I will.	3.32 (1.25)	Zenker et al. (2021)	0.56
	I will do my best to improve my ability to travel.	3.34 (1.07)		0.76
(α=0.80)	I will keep on gathering travel-related information in the future.	3.18 (1.05)		0.55

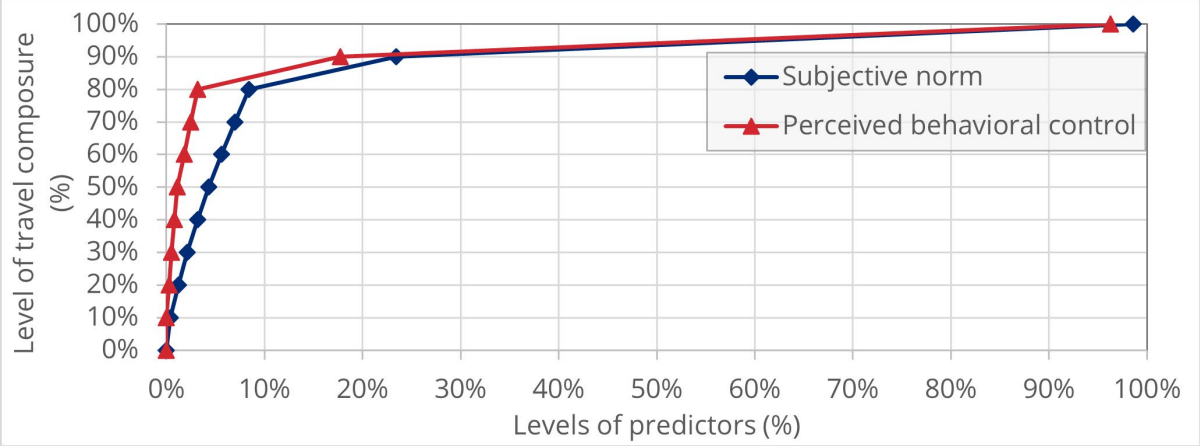
Table B-3 Summary of results for the hypotheses

Hypotheses	Relationships	Path coefficient	*t*-stat	Decision
H1a	Public trust → Travel attitude	0.54*	12.14	Supported
H1b	Public trust → Behavioral intention	0.27*	8.56	Supported
H1c	Public trust × Travel concern → Behavioral intention	-0.07*	-2.21	Supported
H2a	Subjective norm → Travel attitude	-0.36*	-10.48	Not supported
H2b	Subjective norm → Behavioral intention	0.39#	9.03	Supported
H2c	Subjective norm × Travel anxiety → Behavioral intention	-0.02	-0.60	Not supported
H2d	Subjective norm → Travel composure	0.45#	11.91	Supported
H3	Travel attitude → Behavioral intention	-0.02	-0.57	Not supported
H4a	Perceived behavioral control → Travel composure	0.26#	7.08	Supported
H4b	Perceived behavioral control → Behavioral intention	0.45#	10.03	Supported
H5	Travel composure → Behavioral intention	0.04	1.08	Not supported
H6a	Perceived knowledge → Perceived benefits	0.24#	7.36	Supported
H6b	Perceived knowledge → Behavioral intention	0.07	1.65	Not supported
H7	Perceived benefits → Behavioral intention	0.54#	12.17	Supported

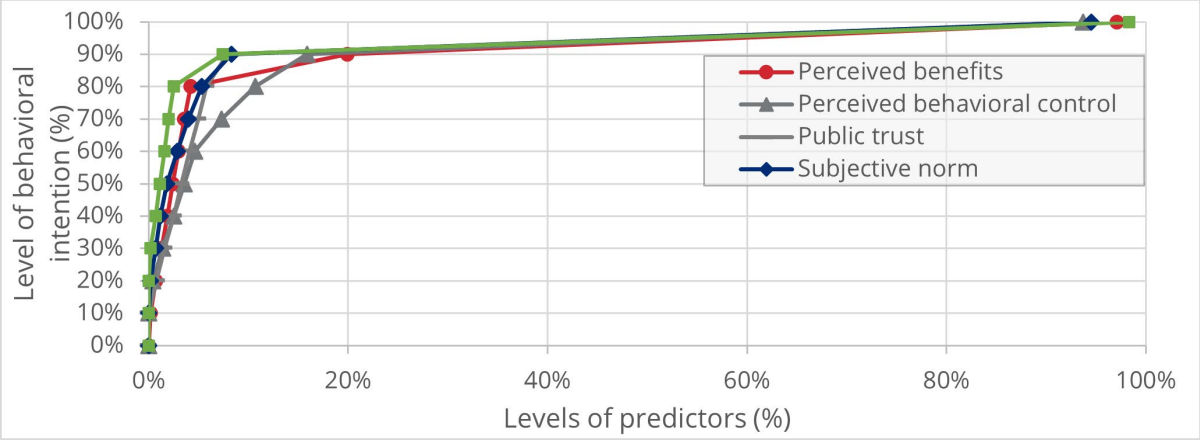
B.2 Interpretation of NCA Bottlenecks and SEM results



(a) Bottlenecks of Public trust for Travel attitude



(b) Bottlenecks of Subjective norm and Perceived behavioral control for Travel composure



(c) Bottlenecks of Subjective norm, Public trust, Perceived behavioral control, and Perceived benefits for Behavioral intention

Figure B-1 Predictor bottlenecks for the outcome to manifest

These bottlenecks, along with the results from SEM can results in one of three scenarios that can be interpreted in detail as follows.

1. Predictor is significant in SEM and NCA **[Scenario-1]**: A change in the predictor variable will change the outcome but a certain level of the predictor variable is necessary for the outcome to manifest. (*Subjective norm → travel composure, perceived behavioral control → travel composure; public trust → behavioral intention, subjective norm → behavioral intention, perceived benefits → behavioral intention, perceived behavioral control → behavioral intention*)

   The public trust-travel attitude bottleneck shows that 90% of intention can be derived within the first 10% of public trust. However, beyond that, a significant amount of perceived trust is needed to get the most favorable attitude (about 95%).
2. Predictor is not significant in SEM but significant in NCA **[Scenario-2]**: A certain level of the predictor variable is necessary for the outcome to manifest but a change will not affect the outcome. (*Public trust → travel attitude; perceived knowledge → behavioral intention*)

   Between perceived behavioral control and subjective norm, the former manifests travel composure more easily. However, beyond about 22% of their levels, the same increase in travel composure can be expected for the same change in both the predictors. Until the manifestation of 80% behavioral intention, among its predictors, perceived knowledge can most easily increase followed by perceived benefits, subjective norm, public trust, and perceived behavioral control. Note that the effect of perceived knowledge on behavioral intention reflects the second scenario. Surprisingly, the increase in behavioral intention is gradual between 5-16% of perceived behavioral control. There is a steady increase in beyond 90% of behavioral intention with a change in all its predictor variables beyond 20% of their ranges. This suggests that for higher behavioral intention, the first 20% increase in the levels of the predictors is crucial.
3. Predictor is significant in SEM but not in NCA **[Scenario-3]**: Change in the predictor variable will change the outcome and no necessary condition exists for the predictor variable to manifest the outcome. (*Subjective norm → travel attitude; perceived knowledge → perceived benefits*)

   For this scenario, we find that no minimum levels of travel anxiety and concerns are necessary to manifest travel intention, but they are sufficient to manifest the outcome. A similar effect of subjective norm and perceived knowledge on travel attitude and perceived benefits respectively is also observed.

Appendix C: Most popular destinations

Table C-1 List of popular destinations

Region	Destination	Nearest UA	Nearest commercial airport
West	Bass Pro Shops at the Pyramid	Memphis	Memphis Int'l Airport
West	Beale Street Historic District	Memphis	Memphis Int'l Airport
West	Discovery Park of America	Union City	Memphis Int'l Airport
West	Elvis Presley's Graceland	Memphis	Memphis Int'l Airport
West	Memphis Music Hall of Fame	Memphis Downtown	Memphis Int'l Airport
West	Memphis Rock 'n' Soul Museum	Memphis Downtown	Memphis Int'l Airport
West	Memphis Zoo	Memphis	Memphis Int'l Airport
West	MoSH – Memphis Museum of Science & History	Memphis	Memphis Int'l Airport
West	National Civil Rights Museum	Memphis	Memphis Int'l Airport
West	Shelby Farms Park	Memphis	Memphis Int'l Airport
West	Stax Museum of American Soul Music	Memphis	Memphis Int'l Airport
West	Tennessee Safari Park	Alamo	Memphis Int'l Airport
Middle	Andrew Jackson's Hermitage: Home of the People's President	Nashville	Nashville Int'l Airport
Middle	Arrington Vineyards	Arrington	Nashville Int'l Airport
Middle	Country Music Hall of Fame and Museum	Nashville	Nashville Int'l Airport
Middle	Cumberland Caverns	McMinnville	Chattanooga Airport
Middle	Downtown Nashville	Nashville	Nashville Int'l Airport
Middle	Falls Creek Falls	Spencer	Chattanooga Airport
Middle	Jack Daniel Visitor Center	Lynchburg	Nashville Int'l Airport
Middle	Nashville Zoo	Nashville	Nashville Int'l Airport
Middle	Stones River National Battlefield	Murfreesboro	Nashville Int'l Airport
East	American Museum of Science and Energy	Oak Ridge	McGhee Tyson Airport
East	Anakeesta Theme Park	Gatlinburg	McGhee Tyson Airport
East	Bays Mountain Park and Planetarium	Kingsport	Tri-Cities Airport
East	Bristol Caverns	Bristol	Tri-Cities Airport
East	Bristol Motor Speedway	Bristol	Tri-Cities Airport
East	Cherokee Lake	Multiple counties	McGhee Tyson Airport
East	Dollywood	Pigeon Forge	McGhee Tyson Airport
East	Gatlinburg SkyLift Park	Gatlinburg	McGhee Tyson Airport
East	Gray Fossil Site and Museum	Gray	Tri-Cities Airport
East	Historic Downtown Morristown	Morristown	McGhee Tyson Airport
East	Hunter Museum of American Art	Chattanooga	Chattanooga Airport
East	Jonesborough Historic District	Jonesborough	Tri-Cities Airport
East	Manhattan Project National Park	Oak Ridge	McGhee Tyson Airport
East	Museum Center at 5ive Points	Cleveland	Chattanooga Airport
East	Ober Gatlinburg Aerial Tramway	Gatlinburg	McGhee Tyson Airport

East	Rock City Gardens and Lookout Mountain	Chattanooga	Chattanooga Airport
East	Ruby Falls	Chattanooga	Chattanooga Airport
East	Sevierville Downtown	Sevierville	McGhee Tyson Airport
East	Tennessee Aquarium	Chattanooga	Chattanooga Airport
East	Tennessee Theatre	Knoxville	McGhee Tyson Airport
East	The Caverns	Pelham	Chattanooga Airport
East	The Lost Sea Adventure	Sweetwater	McGhee Tyson Airport
East	The Old Mill Square	Pigeon Forge	McGhee Tyson Airport
East	Titanic Museum Attraction	Pigeon Forge	McGhee Tyson Airport
East	Tsali Notch Vineyard	Madisonville	McGhee Tyson Airport
East	Tuckaleechee Caverns	Townsend	McGhee Tyson Airport
East	Wetlands Water Park	Jonesborough	Tri-Cities Airport
East	World's Fair Park	Knoxville	McGhee Tyson Airport
East	Zoo Knoxville	Knoxville	McGhee Tyson Airport

Appendix D: Output from INRIX Trip Analytics

D.1 Memphis

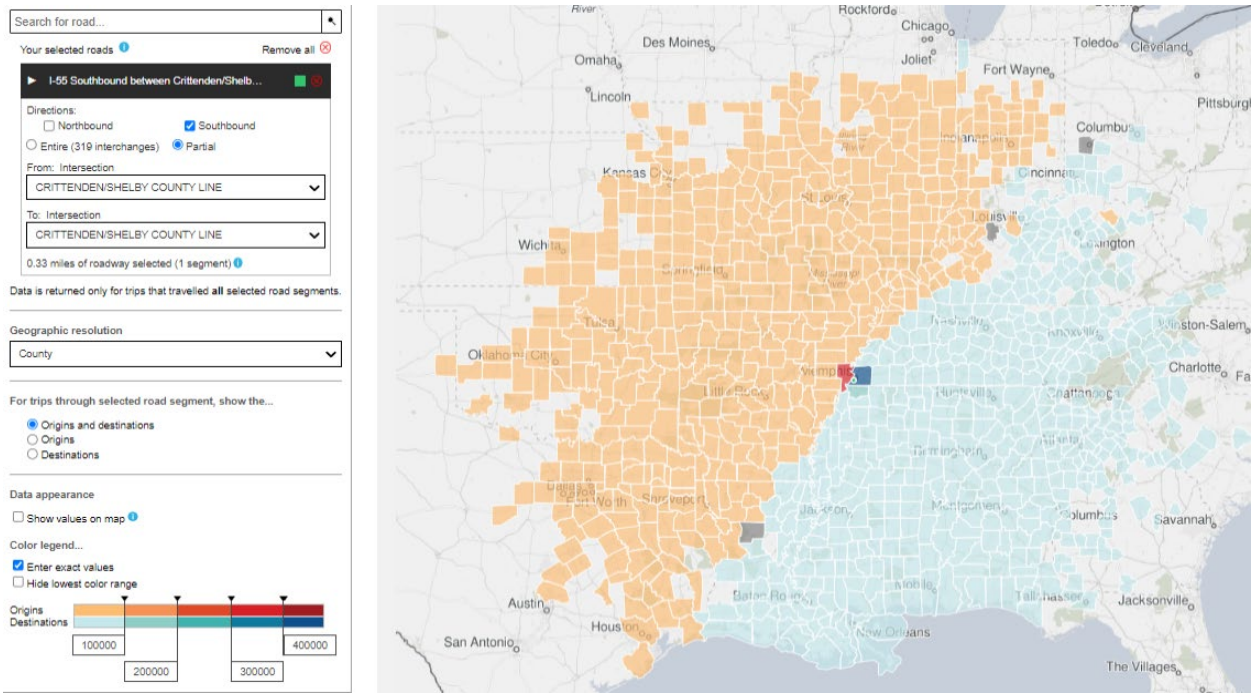


Figure D-1 Origin and destinations of trips made through I-55 E

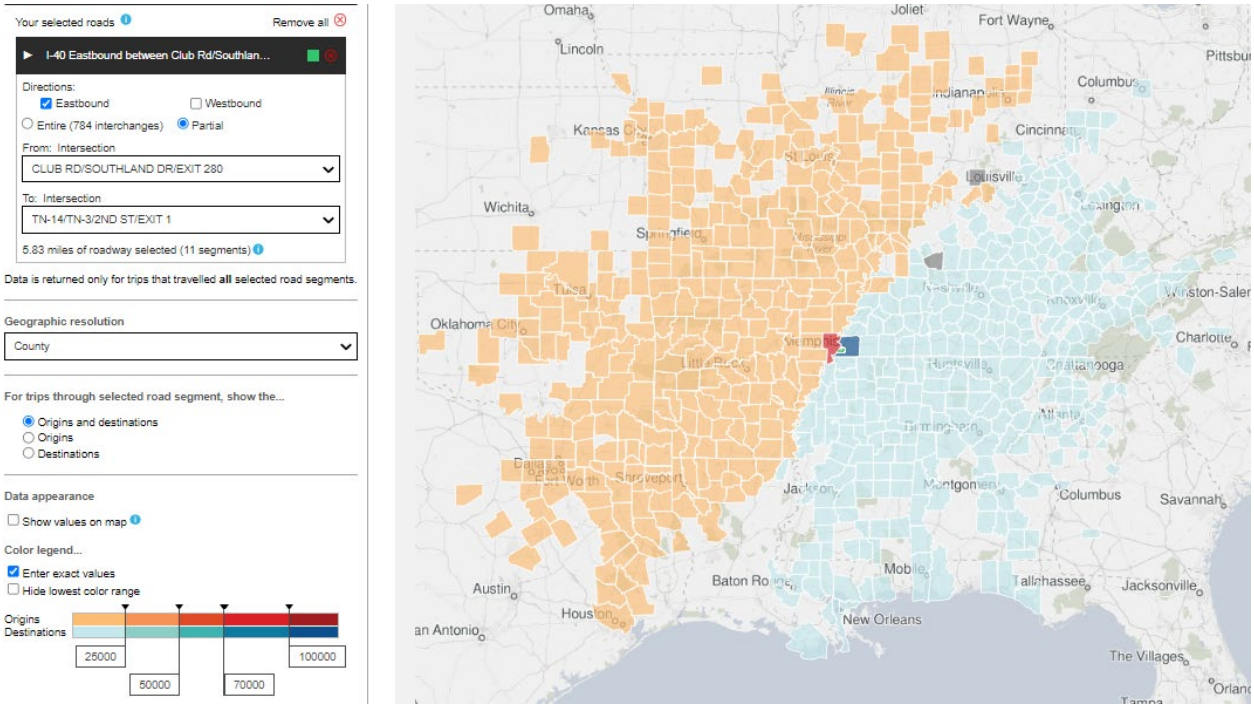


Figure D-2 Origin and destinations of trips made through I-40 E

D.2 Nashville

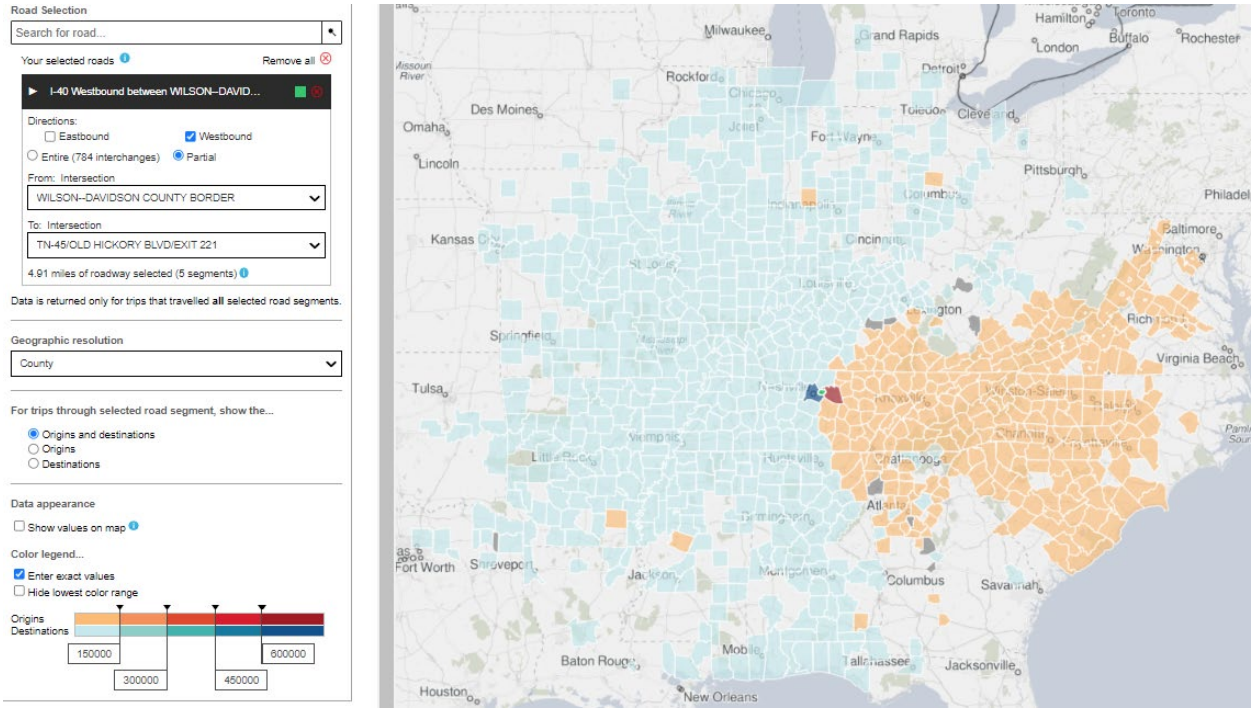


Figure D-3 Origin and destinations of trips made through I-40 W

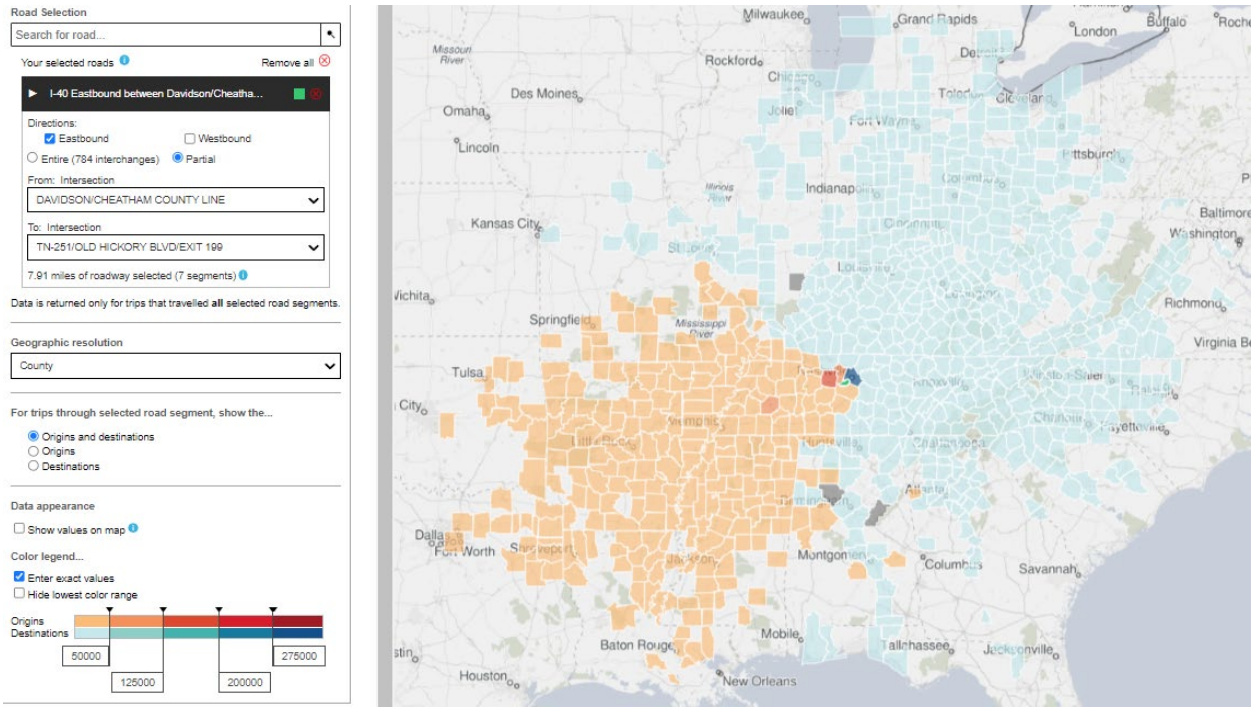


Figure D-4 Origin and destinations of trips made through I-40 E

D.3 Chattanooga

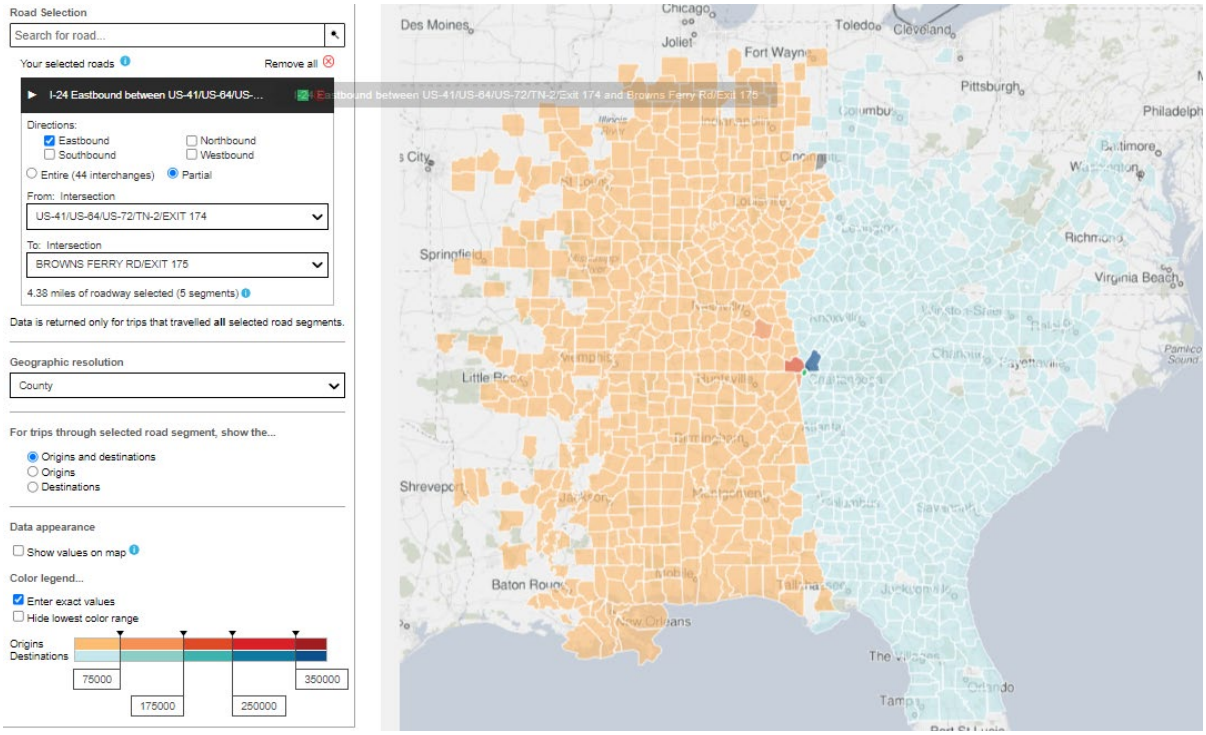


Figure D-5 Origin and destinations of trips made through I-24 E

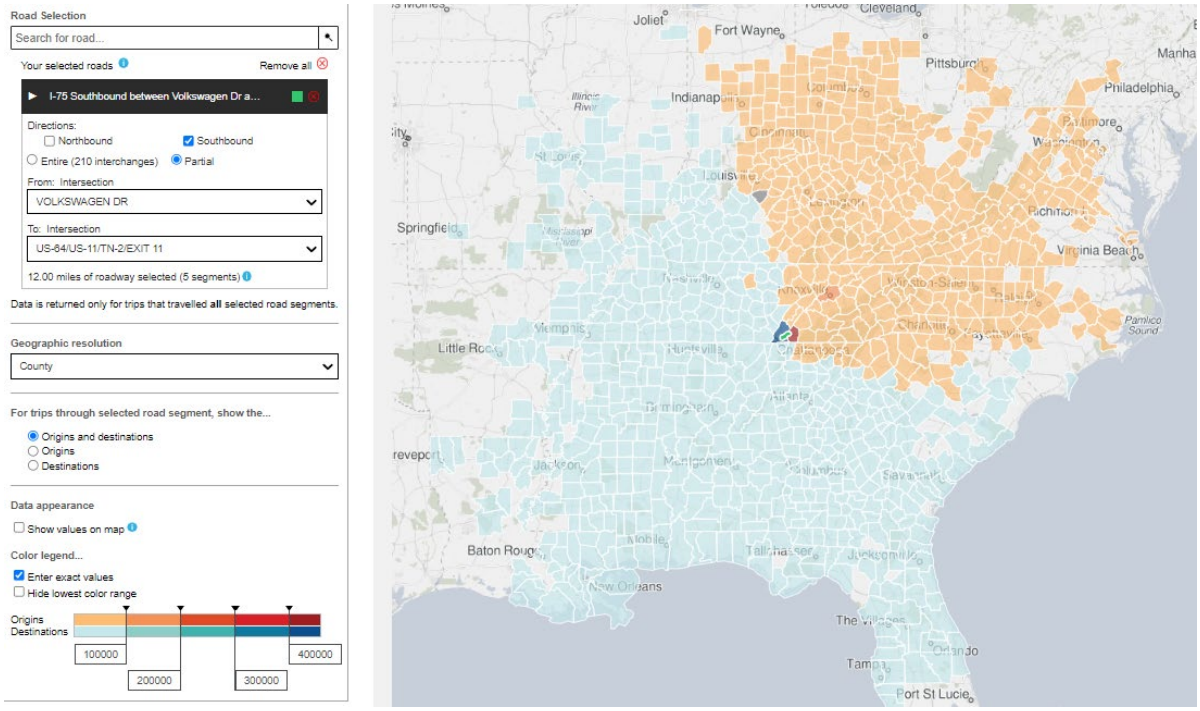


Figure D-6 Origin and destinations of trips made through I-75 S

D.4 Knoxville

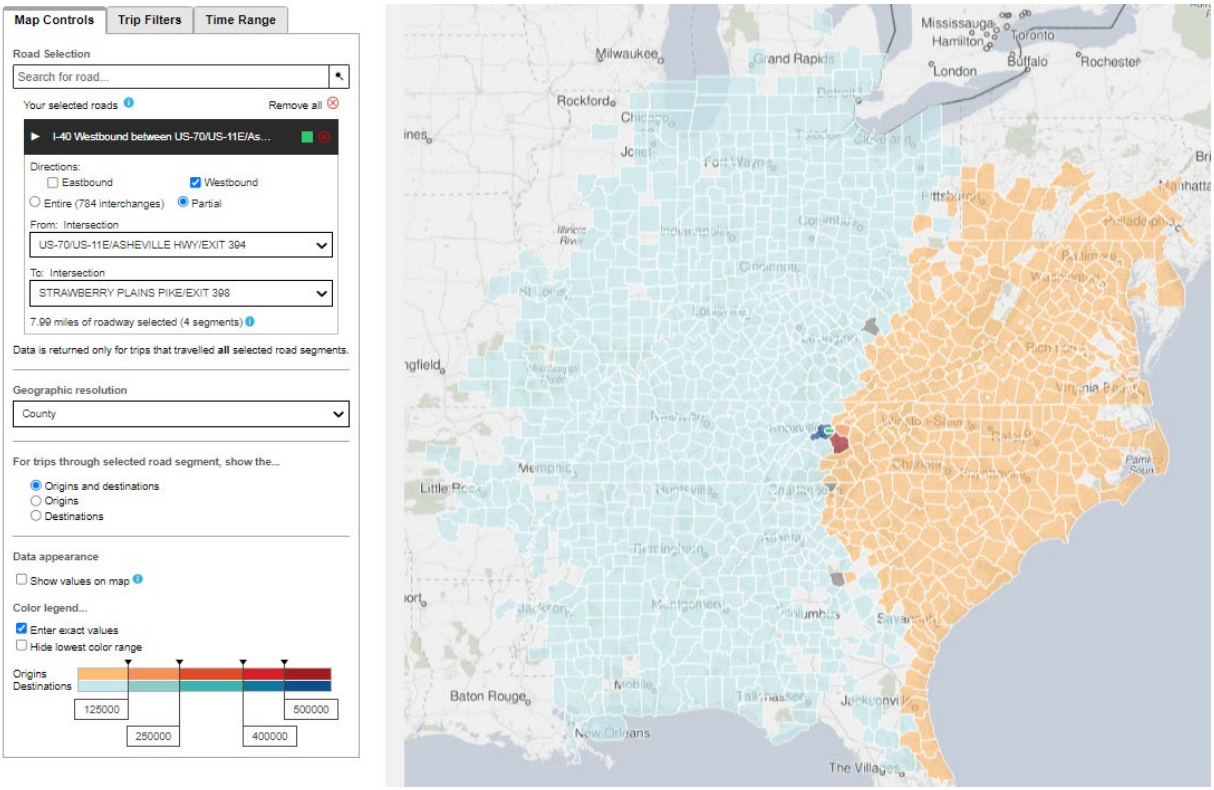


Figure D-7 Origin and destinations of trips made through I-40 W

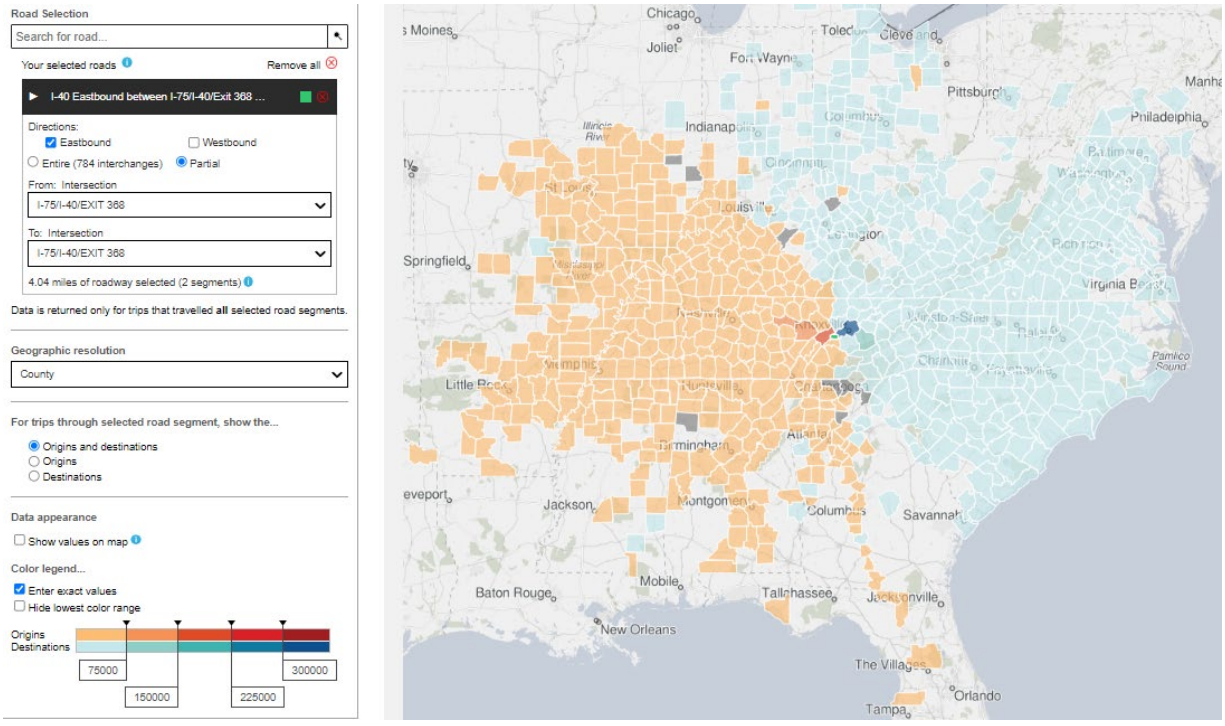


Figure D-8 Origin and destinations of trips made through I-40 E

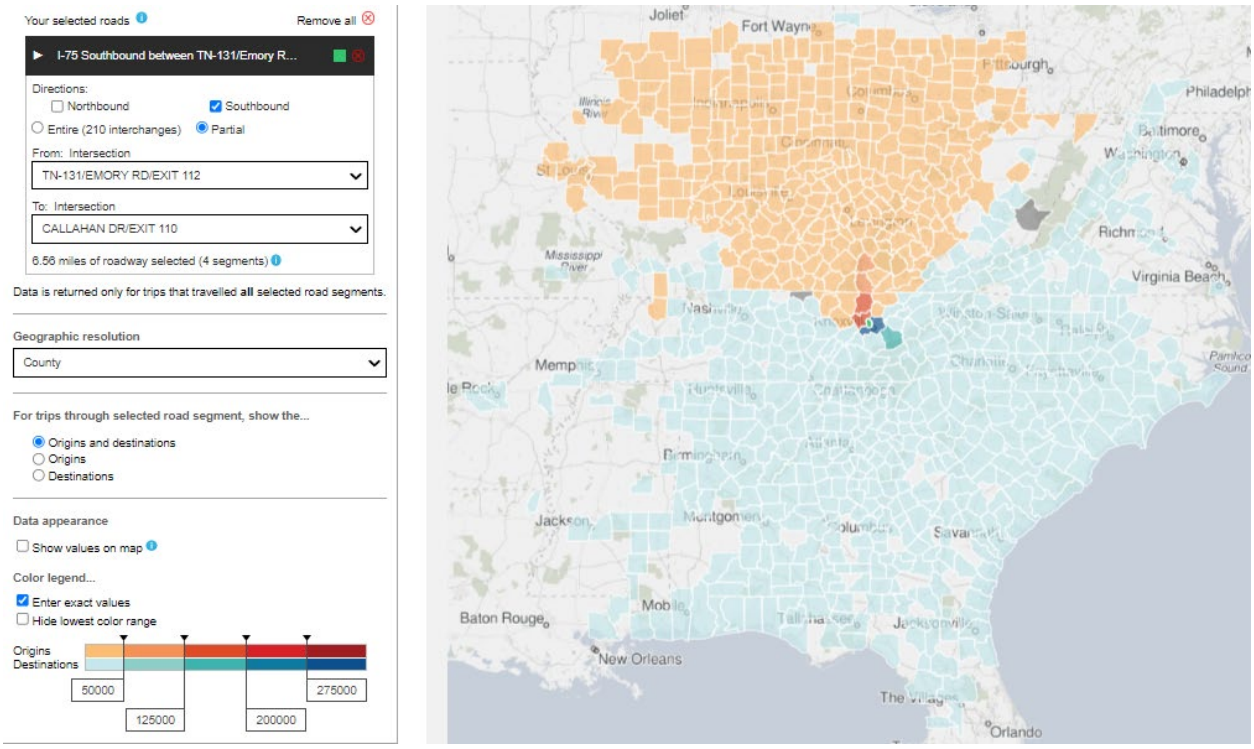


Figure D-9 Origin and destinations of trips made through I-75 S

D.5 Gatlinburg

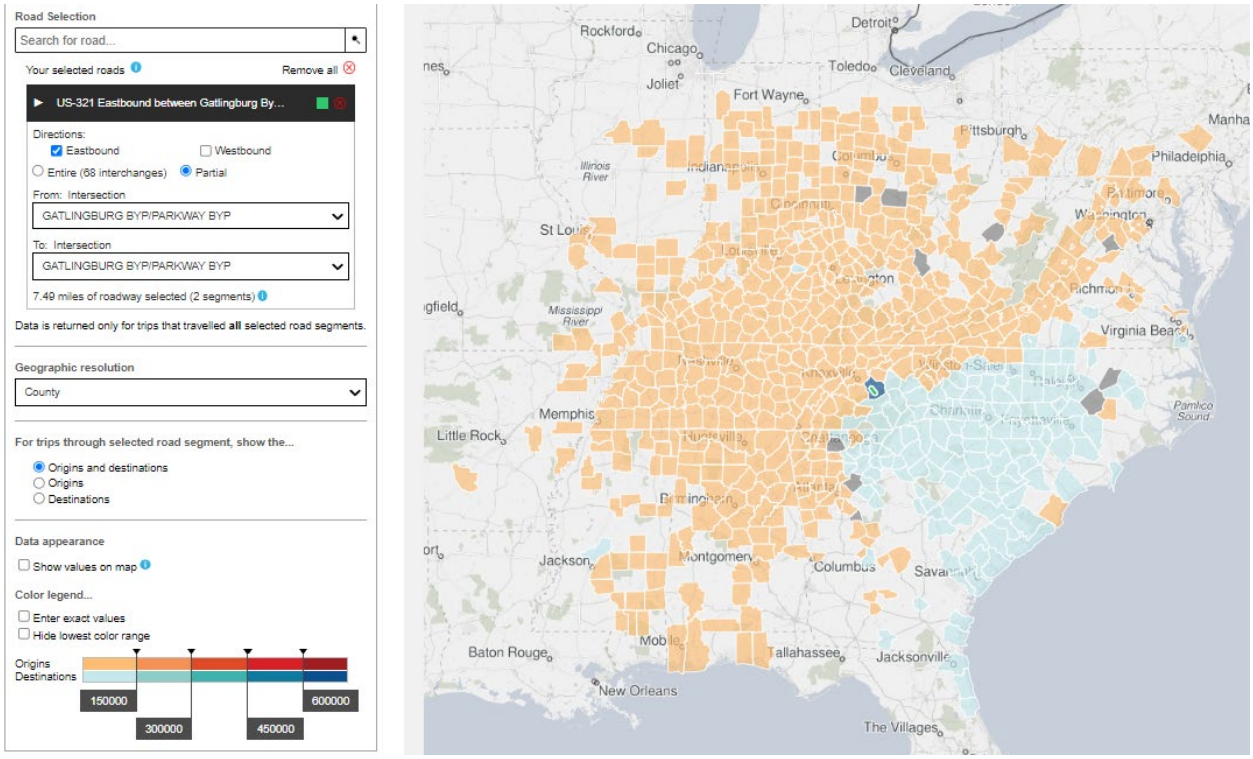


Figure D-10 Origin and destinations of trips made through US-321 S to Gatlinburg

Appendix E: Tourism Agencies in Tennessee

Table E-1 List of survey recipients who were invited to undertake the survey of agencies

West Tennessee	
Benton County-Camden Chamber of Commerce	Humboldt Chamber of Commerce
Brownsville/Haywood County Chamber of Commerce	Lauderdale Chamber/Economic and Community Development
Carroll County Chamber of Commerce	McNairy County Chamber of Commerce
City of Parsons	Milan Chamber of Commerce
Covington-Tipton County Chamber of Commerce	Millington Area Chamber of Commerce
Crockett County Chamber of Commerce	Northwest Tennessee Tourism
Decatur County Chamber of Commerce	Obion County Chamber of Commerce
Dyersburg/Dyer County Chamber of Commerce	Paris/Henry County Chamber of Commerce
Greater Gibson County Area Chamber of Commerce	Reelfoot Lake Tourism Council
Hardeman County Chamber of Commerce	South Tipton County Chamber of Commerce
Hardin County Convention & Visitors Bureau	Visit Brownsville TN
Henderson County Chamber of Commerce	Visit Jackson TN
Historic Downtown Martin	Weakley County Chamber of Commerce
Middle Tennessee	
Bell Buckle Chamber of Commerce	McMinnville-Warren County Chamber of Commerce
Cannon County Chamber of Commerce	Metro Lynchburg/Moore Chamber of Commerce
City of Columbia	Mount Pleasant Community Development Corp.
Clay County Partnership Chamber of Commerce	Nashville Convention & Visitors Corp
Crossville-Cumberland County Chamber of Commerce	Robertson County Chamber of Commerce
Dickson County Chamber of Commerce	Shelbyville-Bedford County Chamber of Commerce
Fayetteville-Lincoln County Chamber of Commerce & Tourism Bureau	Smith County Chamber of Commerce
Franklin County Chamber of Commerce	Smithville-Dekalb Country Chamber of Commerce
Hartsville – Trousdale Chamber of Commerce	South Central Tennessee Tourism
Hickman County Chamber of Commerce	Sparta-White County Chamber of Commerce
Hohenwald/Lewis County Chamber of Commerce	Stewart County Chamber of Commerce
Houston County Area Chamber of Commerce	Sumner County Visitor Center
Jackson County Chamber of Commerce	Tennessee's Backroads Heritage, Inc.
Jamestown/Fentress County Chamber of Commerce	Tullahoma Area Chamber of Commerce
Lawrence County Chamber of Commerce	Van Buren County Chamber of Commerce
Livingston-Overton County Chamber of Commerce	Visit Goodlettsville
Macon County Chamber of Commerce	Visit Pulaski
Manchester Area Chamber of Commerce	Wartrace Chamber of Commerce
Marshall County Chamber of Commerce	Wayne County Chamber of Commerce
East Tennessee	
Campbell County Chamber of Commerce & Tourism	Monroe County Department of Tourism
Chattanooga Visitors Center	Morgan County Tourism Alliance
Cheatham County Chamber of Commerce	Morristown Area Chamber of Commerce

Claiborne Economic Partnership	Northeast Tennessee Tourism Association
Cleveland/Bradley County Chamber of Commerce and Tourism Development	Pigeon Forge Department of Tourism
Coker Creek Welcome Center	Pikeville-Bledsoe County Chamber of Commerce
Elizabethton/Carter County Visitor Center	Polk County Chamber of Commerce
Farragut Community Center	Rogersville/Hawkins County Chamber of Commerce
Follow The Quilt Trail (Appalachian Red Council)	Scott County Chamber of Commerce
Gatlinburg Convention and Visitors Bureau	Sevierville Convention & Visitors Bureau
Grainger County Chamber of Commerce	Sneedville-Hancock County
Greene County Partnership	South Cumberland Chamber of Commerce
Historic Jonesborough Visitors Center	Sullivan County Department of Archives and Tourism
Jellico Tourism Office	Tennessee Association of RV Parks & Campgrounds
Johnson City CVB	Town of Tellico Plains
Knoxville Convention and Visitors Bureau – Visit Knoxville	Townsend Visitor Center
Marion County Chamber of Commerce	Unicoi County Chamber of Commerce
Maynardville/Union County	Visit Jefferson County
Meigs County-Decatur Chamber of Commerce	Visit Kingsport