A Demand Model for Intermodal Travel in the State of Alabama

Dr. Michael D. Anderson and Rajeev Seetharam
Department of Civil Engineering
Dr. Alisha D. Youngblood
Department of Industrial and System Engineering and Engineering Management
University of Alabama in Huntsville
Huntsville, AL 35899
e-mail: mikea@cee.uah.edu

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Transportation; Regression Analysis; Sampling

ABSTRACT

This research features the development of a transportation model that accurately shows the current state of Alabama's infrastructure and allows for predictive analysis of the impact that relocating or developing industries would have on the local areas. A survey was conducted to determine freight volume and movement for a select group of industries. Data from published government sources were also used. Regression analysis was performed to study the relationships between industry size and type and the volume of freight that moves using different modes of transportation. A descriptive model was developed using TRANPLAN that can be used to determine the expected effect of a new business on the local transportation infrastructure. This information can be used by agencies to identify target industries that can promote economic growth while have little negative effect on congestion or requiring significant infrastructure improvements.

INTRODUCTION

Modeling intermodal, statewide freight transportation is an important task to understanding and predicting the transportation infrastructure needs in a region. The Transportation Equity Act for the 21st Century (TEA-21) legislation supported the development of statewide models through identified transportation planning factors, specifically stated "to enhance the integration and connectivity of the transportation system, across and between modes throughout the State, for people and freight". This understanding of the importance of these models has been reinforced by the commitment of the United State Department of Transportation's support for the development of an intermodal, statewide transportation model for Alabama, funded as Grant DDTS59-03-G-00008, "Requirements for Infrastructure and Transportation to Support the Transformation of the Alabama Economy".

The bases for the development of a statewide intermodal model are to address the following scenarios,

- What if the industry relocates to Alabama? How does the national flow of goods change within the state?
- What if the industry develops in Alabama? What is the impact on the existing infrastructure?

The understanding of the importance of modeling intermodal freight transportation in Alabama has prompted the development

of a statewide transportation model. The model incorporates the relationships between economic growth and transportation.

This paper examines the development of a transportation travel demand model for Alabama. The paper contains a brief literature review of other recently developed statewide models, presents the methodology for the Alabama model, documents the development of the model and makes conclusions and recommendations about the ability of the model to support intermodal infrastructure decisions.

LITERATURE REVIEW

Since the modeling of statewide freight transportation has been supported through existing legislation, several states have developed unique modeling approaches to facilitate this need. This literature review contains a review of some statewide models that have been recently completed.

The Virginia Department of Transportation developed a statewide model using a geographic information system database containing infrastructure data and county demographics (Brogan et al. 2001). In this model, commodity flow data was obtained on a county level basis and a statistical relationship was established between the freight production and attraction. A Fratar Growth model was used to distribute the freight from origin to destination. Researchers in Mississippi developed a prototype simulation model of freight movements using TransCAD for distribution of the traffic and an animation software to display freight flow movements (Tan et al. 2003). A model developed by researchers at the Center for Transportation Research and Education at Iowa State University for the Iowa Department of Transportation uses a layered approach, referred to as the 'Onion Model' for freight flow projections (Souleyrette et al. 1996). Basic model assumptions were that intercity freight transportation doesn't lead to congestion because loading of the all the traffic is not done simultaneously. The model adopted the four step planning process, but the trip generation step was neglected.

METHODOLOGY OF THE MODEL AND APPROACH

The model approach undertaken in this research effort follows the traditional four-step urban transportation planning process. Initially, work was required to prepare a highway infrastructure network and statistical relationships to convert socio-economic data to trips and/or freight flow. As freight flow was a primary focal point for this work, a statistical analysis was performed on the relationship between freight flow and the industries located in Alabama to determine the overall county freight movement. The specific tasks being performed in this effort are: data collection, definition of a relationship between industry and freight flow, network development, and assignment of traffic.

Data Collection

Data were procured from Commodity Flow Survey data (Bureau of Transportation Statistics), the U. S. Census Bureau, and the U. S. Department of Transportation. These survey data give the details about the various shipments from domestic establishments and industries.

The data related to the freight movements by different mode were obtained from the Federal Highway Administration's freight analysis framework section. This data

collection was designed by the Commodity Flow Survey (Bureau of Transportation Statistics), Railway Bill data, and the National Surface Transportation board. It consists of the 1998 shipment movement from various states and also gives the projection of freight movements in the years 2010 and 2020.

Some of the employment data and industry data of Alabama were obtained from the Office of Economic Development at the University of Alabama in Huntsville (UAH) and was used in the regression model developed between freight and industries. This information resulted from a business survey conducted by researchers and included items such as tons of freight moved by varying modes of transportation, amount of freight moving specified distances, type of industry, and number of employees.

Over 150 companies within Alabama were surveyed by the Office of Economic Development at UAH, primarily from the automotive and aerospace industries as well as select minor supporting industries such as fabricated metal, electronics, rubber, and chemicals. (The complete list of industries and a breakdown of the number of companies in each category are shown in Table 1.) The survey was conducted as part of an interview to increase the response rate and ensure consistency with data reporting. Information was collected relative to domestic inbound and outbound freight and international imports and exports. For each of these four categories, the surveyed companies were also asked to predict the approximate percent increase over the next five years and ten years. Information was collected about the use of services provided by customs brokers, freight forwarders, and third party logistics providers. The interviewers asked each of the companies for insight into any transportation related problems the industries are currently experiencing with the shipment or receipt of goods and what types of transportation infrastructure improvements are needed within Alabama to better serve their current and future needs.

Table 1. Industry Categories

Industry Type	Number of Companies
Aerospace	49
Automotive	53
Chemicals	10
Fabricated Metal Products	16
Food & Kindred Products	11
Industrial Machinery	12
Lumber & Wood	12
Paper Products	13
Primary Metals	11
Printing & Publishing	8
Stone, Clay, & Glass	4
Textile Mill Products	10
Transportation Equipment	6

Other socioeconomic data pertaining to county level was obtained from the Census Bureau. It focused on the number of employees in a given industry, using the North American Industry Classification System (NAICS) and Standard Industry Classifications (SIC) codes and will be used to identify the total amount of freight being shipped into and out of each county.

Develop relationship between freight flow and industries

One of the primary uses for the transportation model is to predict changes in the transportation network that would result from industries either relocating to Alabama or developing within the state. The main factors affecting the network are assumed to be the volume of incoming and outgoing

freight, the mode or modes of transportation utilized, and the origin or destination of the freight. Data from the industries surveyed can be used to forecast these parameters for future developing industries.

Statistical analysis is done on the survey data to determine the relationship between industry size and type to the resulting freight flow. The size of an industry is measured by the number of employees. Industry type is categorized using SIC and NAICS codes. Freight volume measurement varies depending on the mode examined. For example, truckload freight is depicted as the number of truckloads moved, while rail freight is measured in tons.

These relationships are examined so that for a developing or relocating industry, a freight flow forecast can be developed using the industry type and size which are both assumed known. As an example, shown in Figure 1 is a scatter plot of the total number of less-than-truckload (LTL) loads in the aerospace industry as a function of the number of employees at that site. As can be seen in this figure, many of the data points are clustered together, but there are a few outliers. Further attention to these data points is needed to identify other factors necessary to better explain these relationships. As these relationships are better understood, given the existing state and capacity of the infrastructure, predictions can be made concerning traffic congestion and required improvements.

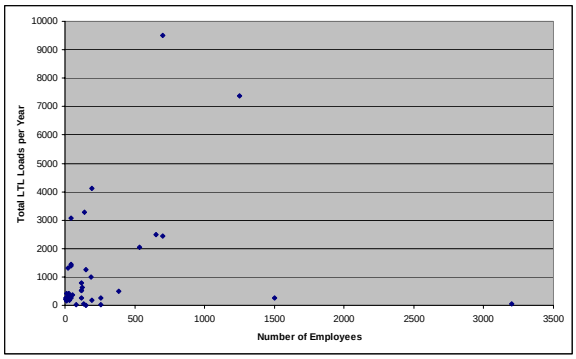

Figure 1. Aerospace Industry Companies

These predictive relationships will be of particular interest to local communities seeking to attract new industries. In addition to the traditional analysis on the local economy, a detailed transportation analysis can be done to determine the effect of various types of industries on the local, existing infrastructure. Communities could then be able to target those industries that would create economic growth and have the least amount of negative impact on the local roadways and waterways.

Network Development

The network was developed using GIS data for Interstates facilities, United States Highways and Alabama State Highways within the CUBE/VIPER environment. There were two separate developed, one focusing on the national highway infrastructure and one focusing on Alabama specific roadways. The national level network identified individual states as traffic zones, while the Alabama specific network used counties as traffic zones. The roadways were attributed with distance, capacity (using Alabama Department of Transportation recommended values), and speed. The networks are shown in Figure 2 and Figure 3.

Figure 2. U.S. Highway Infrastructure

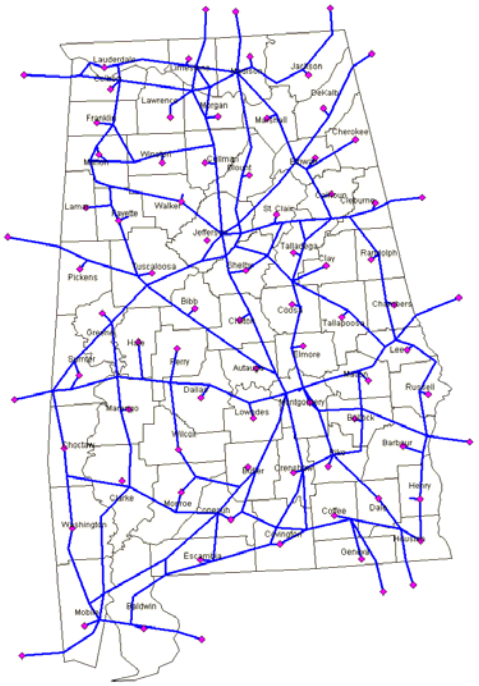

Figure 3. Alabama Highway Infrastructure

Assignment of Traffic

The traffic was assigned to the national network using freight flow information from the Commodity Flow Survey and an all-or-nothing assignment algorithm. Traffic was assigned to the Alabama specific network using the socio-economic data for the counties in Alabama and equilibrium assignment algorithm. The trips were determined using the relationships developed for freight flow from the survey information and personal travel characteristics from the Virginia statewide model, as a personal travel survey was not conducted as a component of this project. The assignment of the Alabama network is shown in Figure 4.

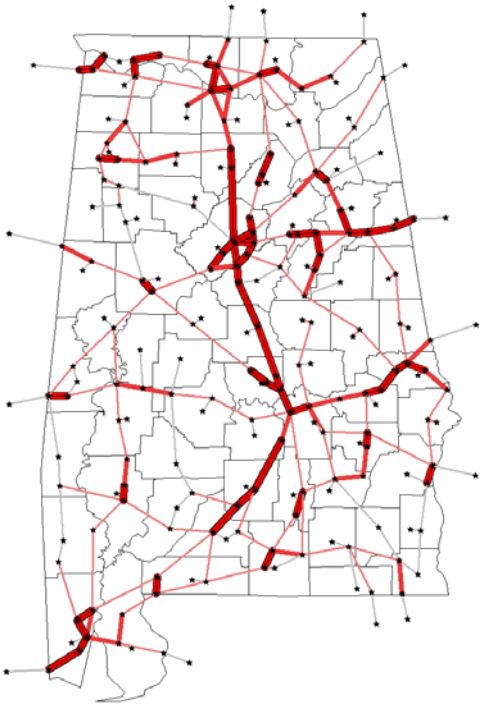

Figure 4. Alabama Traffic Assignment

CONCLUSIONS

The ability to forecast and model freight transportation is important to understanding the relationship between infrastructure and business development. The data collected and model presented in this paper are an important first step to assisting decisions makers in addressing the needs of businesses and understanding how transportation infrastructure decisions can improve or discourage a cohesive business environment.

The future work for this research includes the inclusion of alternate modes of transportation, rail, water and air into the model. In addition, future efforts are examining the business data to determine how transportation infrastructure decisions affect travel mode. The existing forecasting tool only examines the effect of the freight

moving to and from a specific business. It does not incorporate the "trickle down" effect a new industry would have on the local economy. Extensions of this model would need to incorporate a multiplier to include the increase of transportation related to the growth of the local economy stemming from the new industry.

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