Development of a Method to Forecast Freight Demand Arising from the Final Demand Sector and Examination of Federal Data to Analyze Transportation Demand for Local Area Through Trips

Final Report for:
Alabama Department of Transportation
Research Project 930-697

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June 4, 2009

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Table of Contents

Table of Tables

Development of a Method to Forecast Freight Demand Arising from the Final Demand Sector and Examination of Federal Data to Analyze Transportation Demand for Local Area Through Trips

Table of Figures

Development of a Method to Forecast Freight Demand Arising from the Final Demand Sector and Examination of Federal Data to Analyze Transportation Demand for Local Area Through Trips

Executive Summary

This report describes the research performed to develop a framework and a research approach to achieve insight into two important components of freight transportation in Alabama, and the U.S. The first objective is to develop the ability to project freight traffic arising from retail sales to households or to the final demand sector of the economy. Normally, this involves shipments from distribution centers and bonded warehouses to retailers located in the state's population centers. The research demonstrates that this final leg of a shipment's journey to the consumer is growing very fast and evolving rapidly.

Major retail centers were identified in all of Alabama's cities with populations of over 25,000. A subset of the retailers in these communities was chosen for a detailed analysis of their distribution network. The researchers conducted interviews to gather information about how each network operates. The information collected from the survey included the geographical region served, the physical and operational characteristics of the network, volume of traffic, and anticipated future traffic volumes. The survey revealed that most distribution networks serving Alabama can either be characterized as hub and spoke or route-based. The survey also uncovered many unique characteristics of each network.

Finally, researchers determined a method to allocate freight traffic arising from the final demand sector to Alabama counties. Several variables were tested including population, employment, payroll and personal income. It was found that total personal income of residents in the county appeared to work best with population coming in second.

The second research objective focuses on the use of federal freight flow data to forecast the amount of pass through freight expected in urbanized areas in the state. The report documents procedures developed to utilize the Freight Analysis Framework Version 2 Database to determine the number of vehicles passing through an urban area in Alabama.

The procedures developed in this research focus on the national level pass through data, trips from one state to another that pass through other states only because of that state's location; pass through from the port of entries, where the urbanized area is located on a major corridor; and statewide level through trip data, trips from one part of the state to another that pass through the urbanized area because of its geographic location.

The need for, and application of, the pass through freight forecasting is evident in the transportation planning models each state is expected to develop and maintain for evaluating transportation projects. The ability to forecast accurately the pass through freight movements will benefit transportation planners in urbanized areas by being able to identify freight volumes that must be accommodated by the infrastructure, but for which the local area has no direct method to survey.

1. Introduction

This study had two primary objectives. The first objective of this research was to create a method and a database for use in forecasting freight demand arising from the household sector. This demand comes both from households within Alabama and from households in other states when finished goods are transshipped through Alabama. Total truckloads of freight entering Alabama are a function of some variable used to measure final sales to households. This variable could be personal income, household income or total retail sales to the state's residents, but to date, the appropriate factor has not been identified or tested.

The total truckloads of freight entering, moving within or leaving Alabama can be calculated by summing the total truckloads entering the state and the total truckloads leaving the state and the total truckloads shipped within the state. The attraction of freight is a function of final sales to Alabama households plus sales to households outside Alabama. With final demand increasing there will be an associated increase in the attraction of freight due to the new sales in an area. The opposite occurs when final demand is declining.

The benefit to the Alabama and the Department of Transportation (ALDOT) as a result of this first research objective is two-fold. First, the freight servicing the retail sector of the state and the nation is growing at an extremely fast rate as more supply chains become international with the growth of global manufacturing capability. This trend will not soon reverse, which indicates that the freight factor on our interstate, highway and state roads is going to become a more significant component of congestion throughout the state, especially in urban areas. As a result, the need to forecast freight accurately becomes more important in the planning activities for transportation infrastructure.

The second benefit of this research is the ability to forecast the total freight in the state with more accuracy. Researchers at UAH have been developing methods for forecasting freight as a result of manufacturing activity in the state which has resulted in the creation of the Freight Planning Framework (FPF) and the Alabama Transportation Infrastructure Model (ATIM) and the ability to simulate transportation system behavior over time. This research adds an important component to the freight demand on that infrastructure due to the fact that household demand ends up in a truck on a road at some point in the supply chain process.

One of the results of this project is the ability to provide more accurate forecasts of freight demand on the roadways of Alabama to the transportation planners at ALDOT and the state MPO's.

The second objective of this research was to use the US Department of Transportation Freight Analysis Framework Version 2 (FAF2) database to provide state and local government's access to transportation information related to freight origin/destinations. This information is produced and intended to support transportation planning activities within the states and local agencies as the data can be mined to determine sub-regional commodity flows and patterns. Unfortunately, the sheer volume of the database has limited its usefulness to state and local agencies as the nearly 1 million entries are often overwhelming to first time users. Some of the purposes of this project were to extract data from the FAF2 Origin-Destination database to support transportation planning activities within Alabama and for the local regions as well as develop a repository for such data to allow for easier access to the information for future use.

The data provided by the Freight FAF2 database identifies origin/destination locations for freight movements, by commodity, mode and amount. A sample from the dataset is shown as Figure 1.1.

FAFOD_DOM_2002 : Table

Origin	Destination	Commodity	Mode	Mdol	Kton
AL rem	MI rem	Articles-base metal	Other intermodal*	1.12	0.003
AL rem	MI rem	Articles-base metal	Truck	8.765	4.535
AL rem	MI rem	Base metals**	Truck	38.004	39.36
AL rem	MI rem	Basic chemicals	Truck	7.664	1.486
AL rem	MI rem	Chemical prods.	Truck	4.47	1.377
AL rem	MI rem	Electronics	Other intermodal*	0.908	0.001
AL rem	MI rem	Electronics	Truck	14.449	3.848
AL rem	MI rem	Fertilizers	Truck	10.825	23.555
AL rem	MI rem	Furniture	Other intermodal*	1.126	0
AL rem	MI rem	Furniture	Truck	6.258	2.377
AL rem	MI rem	Machinery	Other intermodal*	1.802	0.019
AL rem	MI rem	Machinery	Truck	44.059	2.263
AL rem	MI rem	Meat/seafood	Truck	7.398	5.914
AL rem	MI rem	Misc. mfg. prods.	Air, air & truck	0.595	0.26
AL rem	MI rem	Misc. mfg. prods.	Other intermodal*	0.89	0.046
AL rem	MI rem	Misc. mfg. prods.	Truck	6.996	3.539
AL rem	MI rem	Mixed freight	Other intermodal*	0.865	0.009
AL rem	MI rem	Mixed freight	Truck	0.308	0.398
AL rem	MI rem	Motorized vehicles***	Other intermodal*	13.472	0.09
AL rem	MI rem	Motorized vehicles***	Truck	159.683	28.127
AL rem	MI rem	Newsprint/paper	Other intermodal*	0.218	0.01
AL rem	MI rem	Newsprint/paper	Truck	20.088	51.665
AL rem	MI rem	Nonmetallic minerals	Rail	0.198	6.134
AL rem	MI rem	Other foodstuffs	Truck	10.349	7.44
AL rem	MI rem	Pharmaceuticals	Truck	15.11	0.215
AL rem	MI rem	Plastics/rubber	Other intermodal*	0.153	0.104
AL rem	MI rem	Plastics/rubber	Truck	21.582	8.608
AL rem	MI rem	Precision instruments	Other intermodal*	0.398	0.001
AL rem	MI rem	Printed prods.	Truck	5.974	1.958
AL rem	MI rem	Textiles/leather	Other intermodal*	0.686	0.296
AL rem	MI rem	Textiles/leather	Truck	19.682	6.416
AL rem	MI rem	Tobacco prods.	Other intermodal*	0.636	0.001
AL rem	MI rem	Transport equip.	Truck	6.446	0.256
AL rem	MI rem	Wood prods.	Other intermodal*	0.846	0.024
AL rem	MI rem	Wood prods.	Rail	4.438	27.197
AL rem	MI rem	Wood prods.	Truck	8.28	42.062
AL rem	MN Minne	Articles-base metal	Other intermodal*	2.268	0.002
AL rem	MN Minne	Articles-base metal	Truck	6.773	5.636
AL rem	MN Minne	Base metals**	Other intermodal*	0.35	0.026
AL rem	MN Minne	Base metals**	Truck	17.449	25.573
AL rem	MN Minne	Chemical prods.	Truck	4.349	0.689
AL rem	MN Minne	Electronics	Air, air & truck	16.222	0.008
AL rem	MN Minne	Electronics	Other intermodal*	2.287	0.014

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Figure 1.1. Sample screen shot from the Freight Analysis Framework Commodity Flow Database

The research involved disaggregating the extracted freight data to focus on the impact of through freight trips on the local communities. These through freight trips are becoming an increasing matter of concern in the local communities as freight transportation has a large impact on the performance and quality of the transportation system in a local area, both with respect to roadway congestion and infrastructure needs.

A direct benefit of this research to both ALDOT and the Metropolitan Planning Organization (MPOs) within the state is realized through the development of the methodology to sort the massive database into useable information and, through analysis, to assimilate the filtered data into the transportation planning process. This can be done at both the state and local level. This project is intended to contribute to the FPF and a new freight modeling environment being develop at UAH which is intended to improve the status of freight and traffic estimation.

This report documents the completion of each task and the method that was developed to forecast freight demand originating from the household sector and the pass-through freight. The report is divided into four distinct sections. This first section provides a general introduction. The second section contains the work performed related to the final demand aspects of this project. The third section contains work performed on the pass-through freight. The report provides a conclusion section and identifies area for potential future research.

2. Final Demand Freight Forecasting and Distribution

Project Scope

The purpose of this portion of the research project was to develop a methodology for forecasting final demand arising from the household sector considering the global supply chains of major retailers. A better understanding of the distribution networks for major retail industry sectors in Alabama should improve infrastructure planning to support growing freight volumes.

Project Components

The Final Demand Freight research on distribution networks and forecasting is composed of five tasks. These tasks are:

1. Identification of major distribution centers of finished goods serving Alabama
2. Identification of Shipping Areas (Networks) for distribution centers
3. Capture information regarding the size and number of shipments at distribution centers
4. Create a methodology to identify destinations for distribution centers using an industry database
5. Create a methodology to project final demand in Alabama by destinations (67 counties)

The research approach, analysis, findings, and/or results for each task are described below.

2.1 Identification of major distribution centers of finished goods serving Alabama – Task 1

David Berkowtiz, Ph.D. served as the lead for this task which was to identify major distribution centers of finished goods serving Alabama in the following sectors:

- Big Box Supply Stores
- Furniture
- Fuel Distributors
- Pharmacies
- Autos
- General Merchandise
- Grocery Chains
- Home Electronics
- Sporting Goods
- Parcel Services

Secondary research on the locations of distribution centers and retail stores in Alabama was gathered by a student research team under the guidance of Dr. Berkowtiz. For each sector, students examined industry databases to identify locations, contacts, and facility characteristics. The objective was to provide a detailed spatial analysis of retail shopping in the state's major population centers. Initial data gathered suggested differences in the number and types of retail centers based on population size. After examining the data, the team defined the major population centers as cities with population over 25,000 people. With this focus, data refinements to ensure that all data were being reported consistently became much more manageable.

Alabama retail store locations were identified for each company within the selected industry sectors utilizing a national internet research database, *Reference USA*. This database was selected because the desired data elements appeared to be most accurate and complete of the potential data sources reviewed. Telephone directory listings were used to verify locations. Location data by zip code was gathered to ensure appropriate geographic coverage at the county level. Data collection of retail store locations includes sales volume, number of employees, and contact information.

The location analysis included the following tasks:

- Detailed retail and spatial analysis of the all cities with a population of over 25,000 concentrating on identifying the highest-potential areas for retailing. This was accomplished by investigating the highest spending in the target business categories.

- For those areas identified as having the highest overall potential to support retail, a detailed site-by-site evaluation analysis of locations and numbers of residents in the targeted area was conducted.

- The resulting information provided insight necessary to develop a data gathering survey for both on-site and phone interviews. The survey and analysis of firms in each high-potential area were conducted to determine the specific characteristics about their service operation.

By combining the spatial analysis with the survey analysis, a better assessment of the freight transportation volumes for specific locations was possible and met the objective of finding the highest potential traffic volumes across the industry sectors.

Data on retail stores within a variety of industries were collected and organized by retailer. For each industry, the largest volume producers were selected. The analysis of the retail sales data from *Reference USA* allowed appropriate comparisons. Cities with a population size of at least 25,000 were used to narrow the choices for data collection. This resulted in data on retailers in seventeen cities. Table 2.1 below outlines a sample of the data collected for one of the major electronics retailers, Circuit City.

Table 2.1. Example Table of Circuit City Stores for Alabama

Example Table of Circuit City Stores for Alabama									
Store Name	Address	City	St	Zip	Phone	Volume	# of Employees	Contact Last Name	Contact First Name
Circuit City	704 S Quintard Ave	Anniston	AL	36201	(256)238-9709	$10 to $20 Million	60	Brewer	Jeffrey
Circuit City	2000 Riverchase Galleria	Birmingham	AL	35244	(205)823-5566	$2.5 to $5 Million	9		
Circuit City	4351 Creekside Ave	Birmingham	AL	35244	(205)989-9321	$10 to $20 Million	60	Smith	Brandon
Circuit City	7720 Ludington Ln	Birmingham	AL	35210	(205)956-8493	$1 to $2.5 Million	5	Obermeyer	Steve
Circuit City	2821 Montgomery Hwy	Dothan	AL	36303	(334)673-8807				
Circuit City	5900 University Dr NW	Huntsville	AL	35806	(256)722-9425	$20 to $50 Million	100	Leslie	
Circuit City	3725 Airport Blvd	Mobile	AL	36608	(251)460-0421	$20 to $50 Million	70	Faggard	Rob
Circuit City	3987 Eastern Blvd	Montgomery	AL	36116	(334)284-8306	$10 to $20 Million	55	Telfair	Corey
Circuit City	2600 Mcfarland Blvd E	Tuscaloosa	AL	35405	(205)343-9540	$10 to $20 Million	45	Waldrop	Jason

In Table 2.2, an excerpt from the distribution center database provides information regarding industry sector, company or distributor, city and county.

Table 2.2. Excerpt from Retail/Wholesale Distribution Centers within Alabama Database

Retail/Wholesale Distribution Centers within Alabama			
Sector Name	Company/Distribution	City	County
Apparel	Dillards	Mobile	Mobile
Apparel	Vanity Fair Brands LP	Monroeville	Monroe
Apparel	Simply Fashions Stores Ltd	Birmingham	Jefferson
Apparel	Children's Place		DeKalb
Apparel	VP Jeanswear LP - Lee Apparel Co.	Holly Pond	Cullman
Apparel	Gerber Childrens Wear	Evergreen	Conecuh
Apparel	Russell Corporation	Montgomery	Montgomery
Auto Parts	Herzog Automotive Parts		Jefferson
Auto Parts	OReilly's	Saraland	Mobile
Auto Parts	Motion Industries -subsidiary of Genuine Parts Company	Birmingham	Jefferson
Auto Parts	CarQuest	Montgomery	Montgomery
Auto Parts	Napa Auto Parts -subsidiary of Genuine Parts Company	Birmingham	Jefferson
Auto Parts	Ace Hardware	Loxley	Baldwin
Magazine/Book Distribution	CR Gibson Company	Florence	Lauderdale
Magazine/Book Distribution	Great News Inc	Phenix City	Russell
Magazine/Book Distribution	American Wholesale Book Co	Florence	Lauderdale
Drugstore	Qualitest Pharmaceuticals - Apax Partners	Huntsville	Madison
Drugstore	UniCare Inc	Prattville	Autagua
Drugstore	Respiratory Distributors	Foley	Baldwin
Drugstore	McKesson Pharmaceuticals	McCalla	Jefferson
Drugstore	Rite Aid	Tuscaloosa	Tuscaloosa
Drugstore	CVS Caremark	Bessemer	Jefferson
Furniture	Badcock WS Corp	Cullman	Cullman
Wholesale Grocery	Osborn Brothers Inc	Gadsden	Etowah
Wholesale Grocery	Merchants Company	Clanton	Chilton
Wholesale Grocery	Alabama Food Group	Alexander City	Tallapoosa
Wholesale Grocery	Petrey Wholesale	Montgomery	Montgomery
Wholesale Grocery	MBM Corporation	Montgomery	Montgomery
Wholesale Grocery	Andalusia Distributing Company	Andalusia	Covington
Wholesale Grocery	Halsey Food Service	Huntsville	Alabama

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2.2 Identification of Shipping Areas (Networks) for distribution centers and Capture Information regarding the size and number of shipments at distribution centers - Tasks 2 & 3

Jeff Thompson served as the lead on these tasks which entailed the identification of Shipping Areas (Networks) for distribution centers and the capture of information regarding the size and number of shipments at distribution centers.

Data gathered from Task 1 was used to design a questionnaire to gather freight transportation data from distribution centers as well as retail store locations. Several of the industry segments supply Alabama retail stores from out-of-state distribution centers.

In this case, phone interviews with local store managers were used to collect transportation network information.

A survey questionnaire was developed to gather the following information about the industry freight transportation networks. (See Figure 2.1 for Sample Survey Questionnaire)

- Address and contact data for store location interviewed or distribution center surveyed
- Whether the center identified ships freight to retail stores
- The geographic region served by the distribution location
- How the company manages their freight transportation function
- Size of the distribution facility in square feet
- Utilization factor on current capacity
- Network visibility from the location
- Expansion plans in the next 5 years
- Value of goods handled in the previous year at this location
- Annual volume change over the past 5 years
- Annual volume change expected 5 years into the future
- The source of inbound shipments (manufacturer, distributor, wholesaler, etc.)
- Seasonality of the operations
- Peak times of day for receipts and shipments
- Inventory turn rate expressed in days
- Percentage of cross docking of inbound freight
- Percentage of volume transported by company owned/leased, common carrier, or a combination
- Number of employees at the location
- Current transportation issues for the company

ID Code: ______

Freight Forward Transportation Survey   UAH – Office for Freight, Logistics and Transportation

	FILL IN BEFORE VISIT:	**DATE OF SURVEY:**	____/___/_____
1	Company Name:	______	
2	Street Address:	______	
3	City	______	
4	State	______	
5	Zip	______	
6	Phone:	______	
	COMPLETE AT INTERVIEW:		
7	Contact Name:	______	
8	Contact Title/Position:	______	
9	Email Address:	______	
	BEGIN SURVEY QUESTIONS:		

10 Does your company at this location:

Ship products to retail locations within the State of Alabama? YES NO

11 What is the number of stores served from this location: Total Stores: ______

Alabama Stores: ______

12 What geographic region (by state or within AL - by county) does this location/warehouse serve?

All States Served: 1.______ 2.______ 3.______ 4.______ 5.______ 6.______

All AL counties served: 1.______ 2.______ 3.______ 4.______ 5.______ 6.______

(Ask for a list of Stores Served)

Note: ______

13 From what other location(s) does your company ship retail goods into State of Alabama?

#1 Location Name/City : ______

#1 Location Contact Name: ______

#1 Location Phone Number: ______

#2 Location of Warehouse # 2: ______

#2 Location Contact Name: ______

#2 Location Phone Number: ______

14 Does your company control the transportation of freight in and out of this facility?

YES NO

15 What is the total square footage at this location?

Square footage: ______

16 What percentage of capacity of this location is being used?

Today (circle one)	1-25%	26-50%	51-75%	76-100%
In Five Years (circle one)	1-25%	26-50%	51-75%	76-100%

Note: ______

Figure 2.1. Example of Freight Forward Survey

Companies from each industry sector were selected as targets for interviews. The target companies were ranked based on the number of stores, sales volume, and footprint of their stores in Alabama. It was often difficult to reach the distribution center manager. Familiarity with university research by the operation manager increased the chance of securing an interview. Freight transportation data is considered very proprietary by most companies. However, all companies interviewed shared at least some information. The most sensitive data to acquire was the value of shipments and the question was often not answered.

Data gathered from both interviews and secondary research was utilized to draw representative freight transportation networks for:

- Beverage Distributors
- Big Box Centers
- Furniture
- Fuel Distributors
- Pharmacies
- Automobiles
- General Merchandise
- Grocery Chains
- Home Electronics
- Sporting Goods
- Parcel Services

The freight distribution network for each of these sectors has unique characteristics. Individual companies within a sector may have a radically different distribution strategy from their competitors. In fact, freight transportation system design and strategy are often considered competitive advantages. All of the industry sectors have a similar goal of placing merchandise in the retail stores just in time for the consumer selection. Pressure to reduce investments in inventory continues to increase. Therefore, there is no typical or "model" design that can be followed by transportation planners.

Sector Summaries

Beverage Distributors

The beverage distributor industry sector in Alabama is shaped by state law on alcoholic beverages and territory designations for non-alcoholic beverages. However, both types of distributors use a hub and spoke type of network where the finished product is either received from out of state (alcoholic) or bottled (non-alcoholic) at regional locations. A central location receives out of state shipments of raw materials or finished product from manufacturers, distributors, or port container facilities for imports. Then after processing (bottling or repackaging), ship the product to retail stores on trucks with regular, established routes.

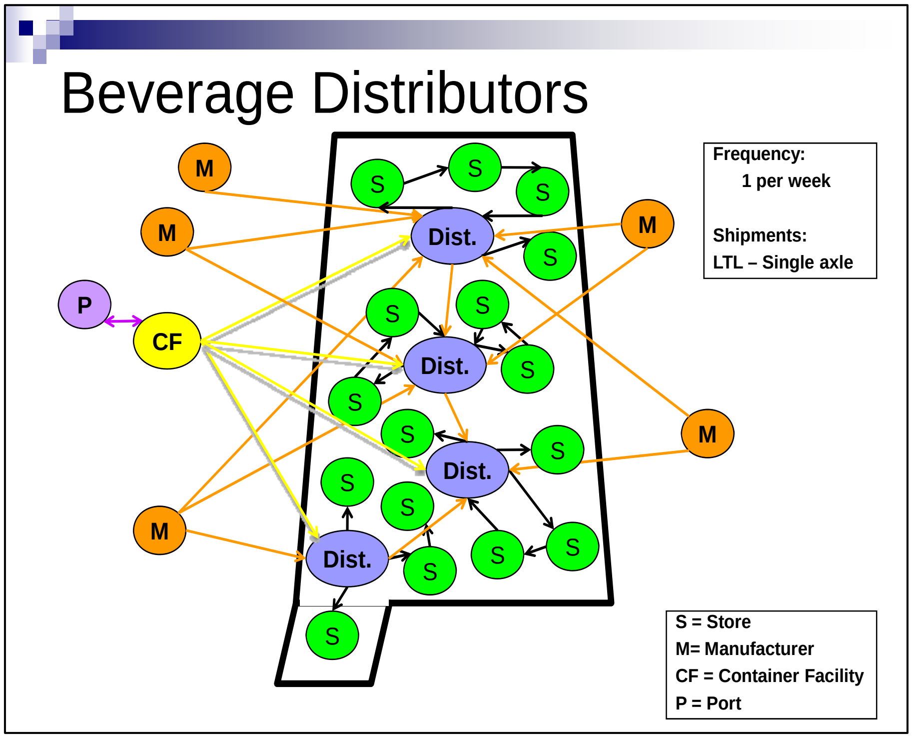


Figure 2.2. Beverage Distributor Network

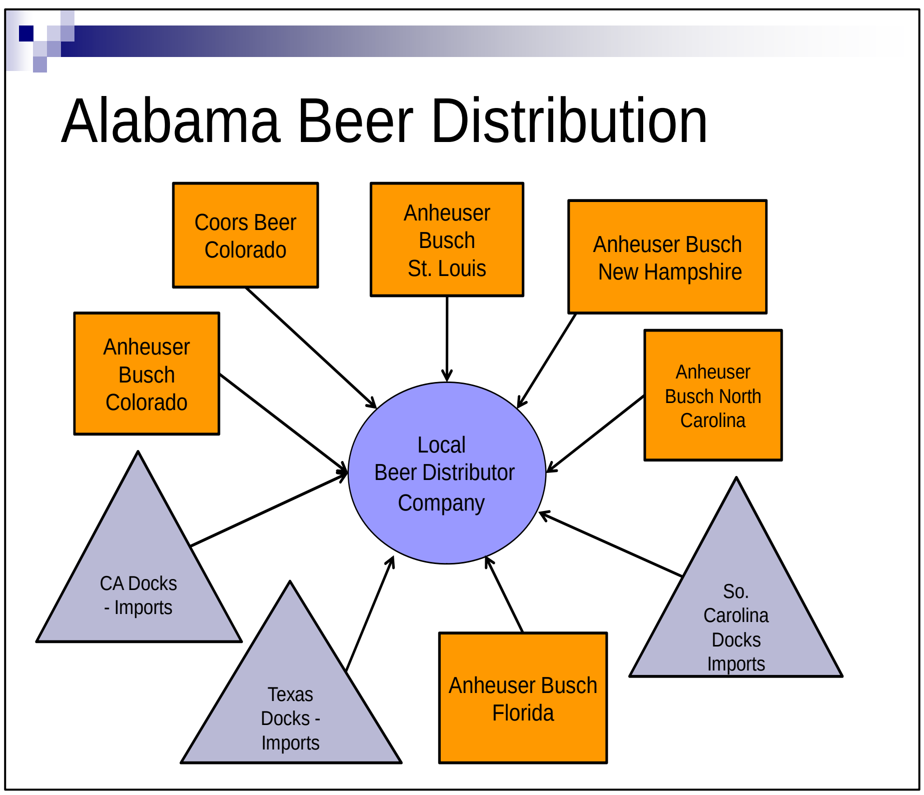


Figure 2.3. Alabama Beer Distribution Network

Big Box Centers

The big box or super center sector in Alabama is configured based on store size and locations which are selected with consideration for population size and density. These centers use a combination of hub and spoke as well as manufacturer delivery to stock their stores. Distribution centers are established where transportation infrastructure will easily support inbound and outbound freight shipments relative to their retail super store locations. Large, bulky items as well as perishable items may be delivered by the manufacturer directly to the retail store. For the majority of the product items, the distribution receives regular shipments from manufacturers, distributors, import container facilities and intermodal facilities. Then outbound truck loads are built for each store on the route. Large centers will receive multiple trucks per day while smaller stores may receive a pallet every few days. Outbound equipment (trailers) may be company owned or leased. Common carriers may be used for less than trailer load shipments across larger geographic areas.

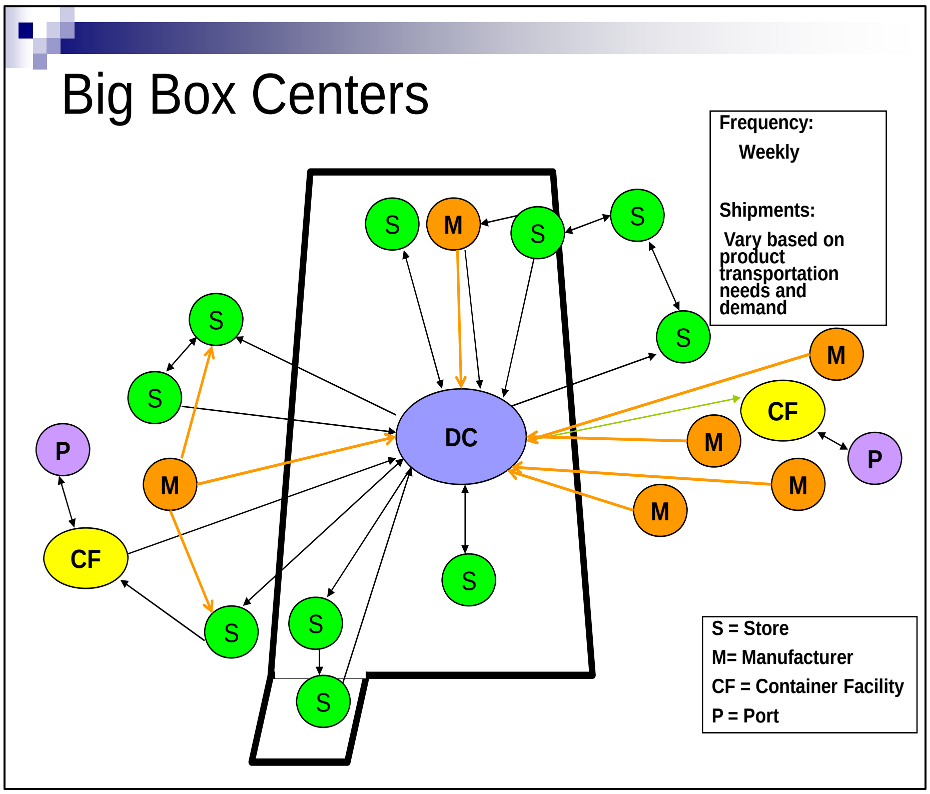


Figure 2.4. Big Box Centers Distribution

Furniture

The furniture industry supply chain has been changing over the past decade. Manufacturing centers in the United States have given way to other parts of North America which are now losing the manufacturing operations to off-shore locations. Although distribution centers and warehouses still exist, their roles in the final demand transportation network are changing from a supplier of retail stores to the delivery of goods to residences and office locations. Furniture stores that carry an inventory are becoming less common as furniture "showrooms" become more popular. The showrooms allow customers to make their selections which are then ordered for delivery to the customer's home. The distribution centers/warehouses are regionally located to serve large geographic areas which may span parts of several states. Manufacturers, distributors, and container facilities ship products to the distribution center. The distribution center takes the products and builds truckloads to be delivered to customers in a geographic region. Of course, product is still delivered to the showrooms from the distribution center as needed for display.

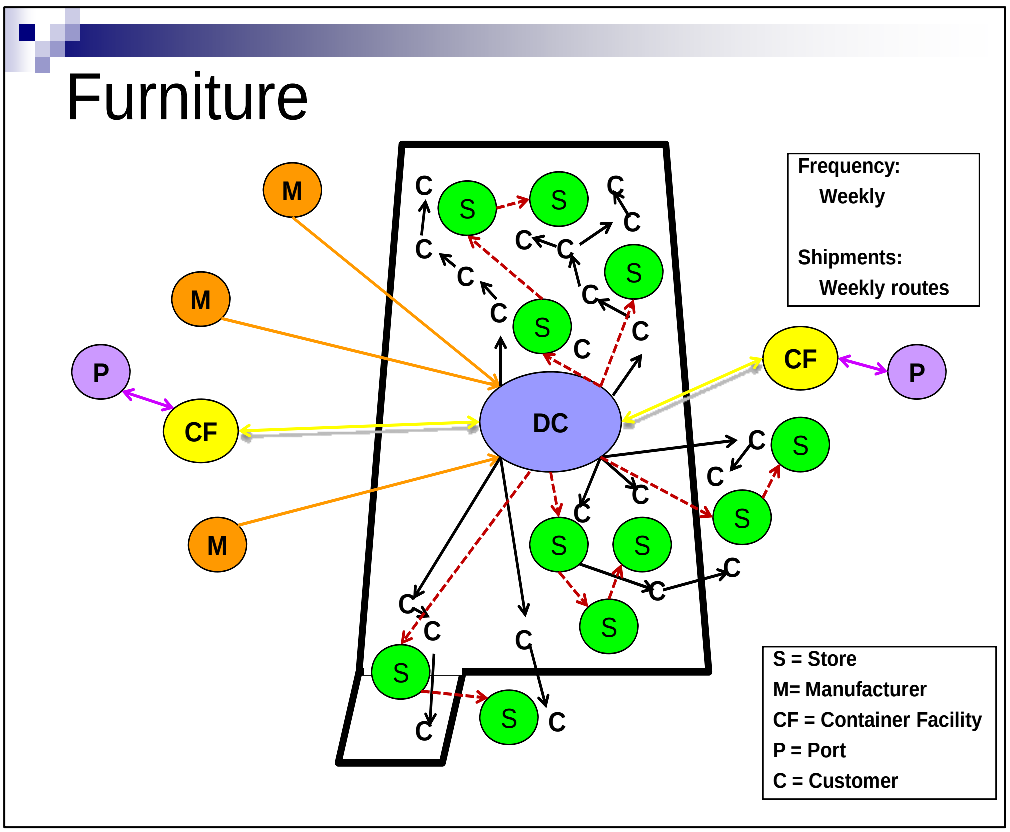


Figure 2.5. Furniture Distribution

Fuel Distributors

Fuel products move through the same hub and spoke design distribution network used for decades. Changes in demand levels have required tweaks to the networks in Alabama but few supply chain links have switched modes since the territorial-based final demand network was established. The supply chain for fuel products (gasoline, diesel, jet fuel, etc.) starts at either a water port or refinery. The product then travels to terminals or tank farms by pipeline. From there, the fuel is trucked to retail stores or customer tanks (e.g., airport) by regional oil companies. Each regional oil company may use a combination of their company trucks or leased carriers, especially in periods of high demand. Much like the furniture supply chain, fuel distributors hold as little fuel in inventory as possible. Instead, customer tanks receive shipments directly from the terminal/tank farms. During times of peak demand, safety stock may be maintained by the oil company. Multiple shipments travel to larger cities and to larger retailers each day.

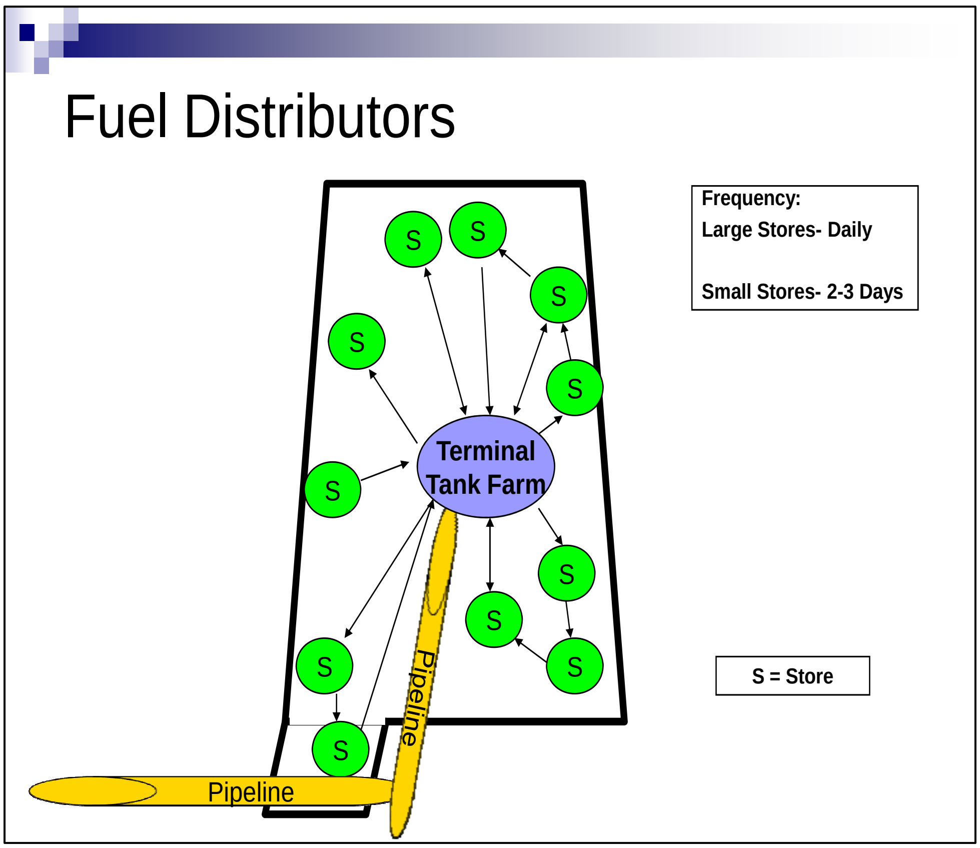


Figure 2.6. Fuel Distribution

Pharmacies

The opening of drug stores continues at a rapid pace. The battle for market share of the drug store chains, grocery chains with pharmacies, and big box retailers with pharmacies has created what seems like pharmacies on every corner. The drug store merchandising plan may cover a very large number of items from food products to hardware to drugs. The transportation plan is segmented by inventory type such as perishable (drugs or food) and staple items. Daily deliveries are made to each store for drugs as well as staple items in most chains. One of the most interesting findings is that one of the companies surveyed uses a third party logistics provider to deliver drugs to each store within a narrow delivery window each day. Parcel services or common carriers may be used to deliver staple products from the distribution centers to the stores on a less than daily schedule. For chains that mostly use their own fleet of trucks or vans, merchandise can be moved between stores or backhauled to the distribution center for return or redistribution. One of the surveyed distribution centers of non-perishable items serves a large geographic area spanning several states and makes direct deliveries to multiple stores several times each week.

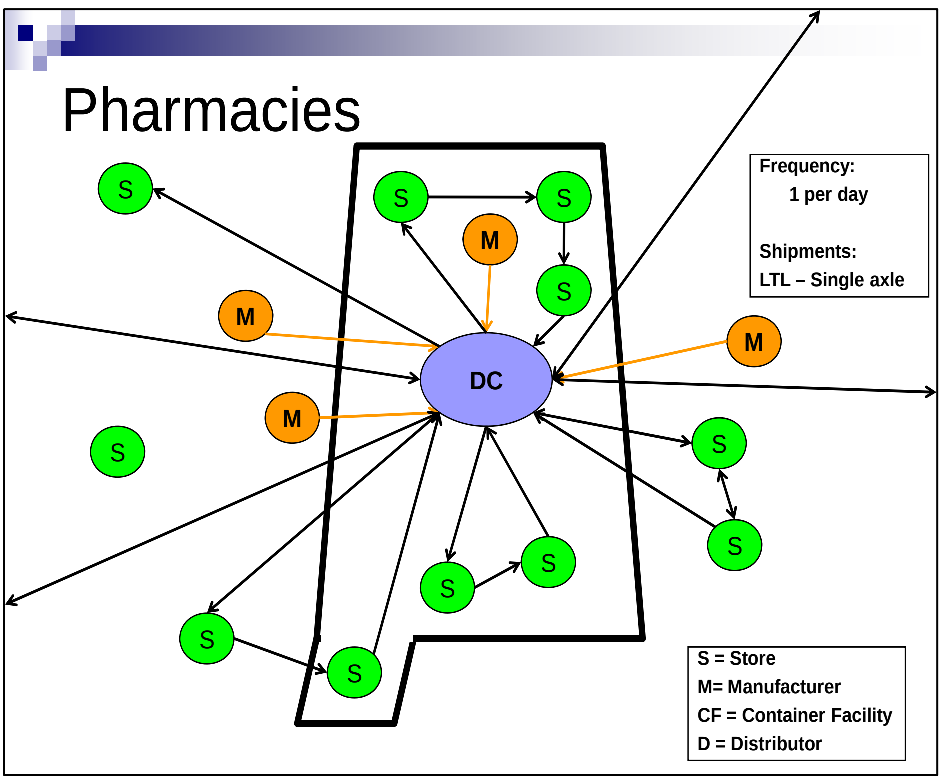


Figure 2.7. Pharmacy Retail Distribution

Autos

The automobile industry sector is one of only a few which use a mode other than trucking to move freight to distribution points. One auto dealer can carry models assembled in the local region, across the country, in Canada, in Mexico and off-shore. Because the origins are so different, regional intermodal yards for autos are created to facilitate shipments to retail dealers. These regional intermodal yards supply multiple states. In Alabama, the supply chain is similar even though there are three assembly plants located in the state. For example, one company assembles two models in Alabama then ships them directly to dealers by truck. Other models by the same manufacturer are shipped from other parts of the country or from water ports. Autos are delivered from the intermodal distribution yard and the assembly plants by truck to Alabama dealers. Specialized common carriers are used by the auto companies to deliver autos. New and used automobiles may be moved between dealers or to auction yards as backhaul freight by the same common carrier delivering new vehicles.

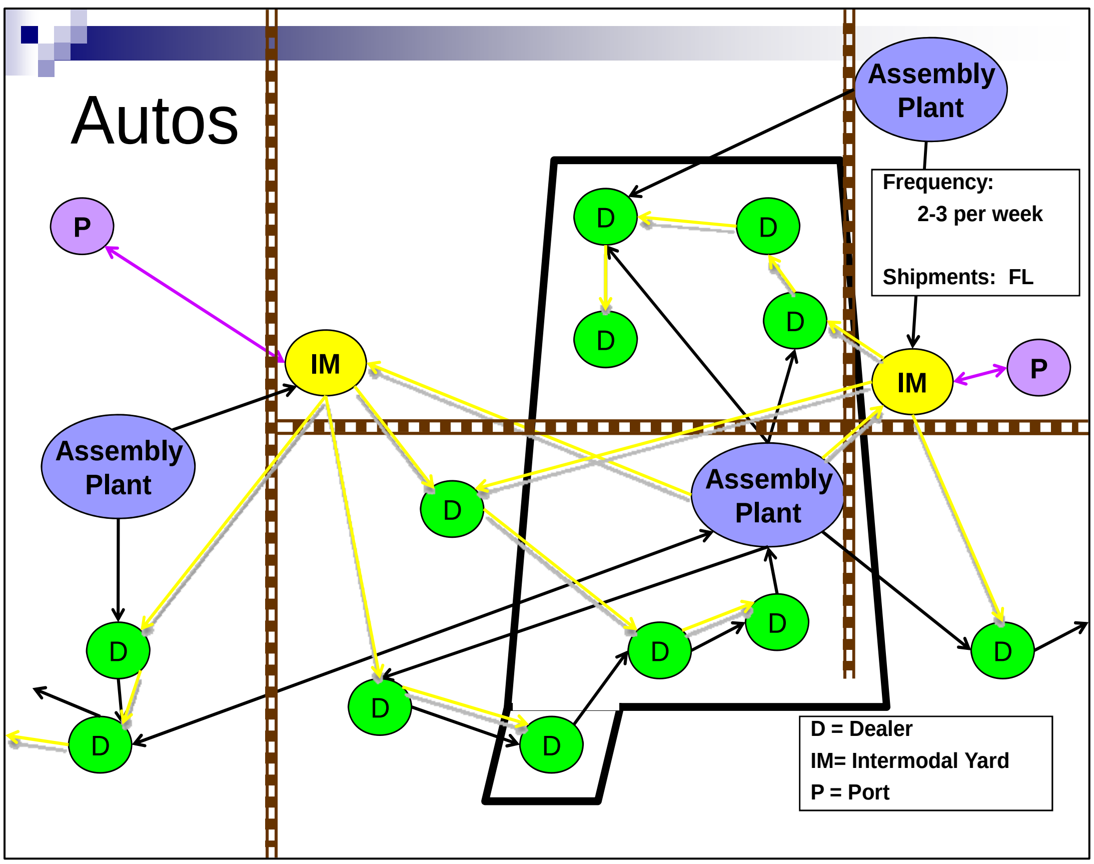


Figure 2.8. Automotive Distribution

General Merchandise

The general merchandise sector includes exclusive department stores to deep discount stores. These stores receive merchandise by company-owned/leased trucks, common carriers, and manufacturer trucks. The marketing strategy of each company significantly influences their transportation network design. Larger chains such as clothing stores that stock a large percentage of their stores with seasonal merchandise are striving to minimize the time required to get products to their stores from the off-shore manufacturers. The result has been the regionalization of distribution centers closer to ports of entry. By eliminating local distribution centers, retail stores can actually receive merchandise several weeks sooner. This reduction in the length of the supply chain allows retailers to enjoy longer periods of premium pricing. Deliveries from the distribution centers are often weekly but daily shipments from manufacturers, distributors, etc., may be received by the store throughout the week. Peak season (Christmas) freight demands are met by using more common carriers or leased trucks. Chains with many stores in geographic regions use a route design to load merchandise at manufacturers, distribution centers, and container processing facilities locations close to the regular routes. In some cases, a fully loaded truck leaves the distribution center once per week to their regular route of stores several states away and does not return to the distribution center until the next week. The truck moves freight between stores as well as picks up freight at manufacturers, ports, etc. to deliver to the distribution center on their return.

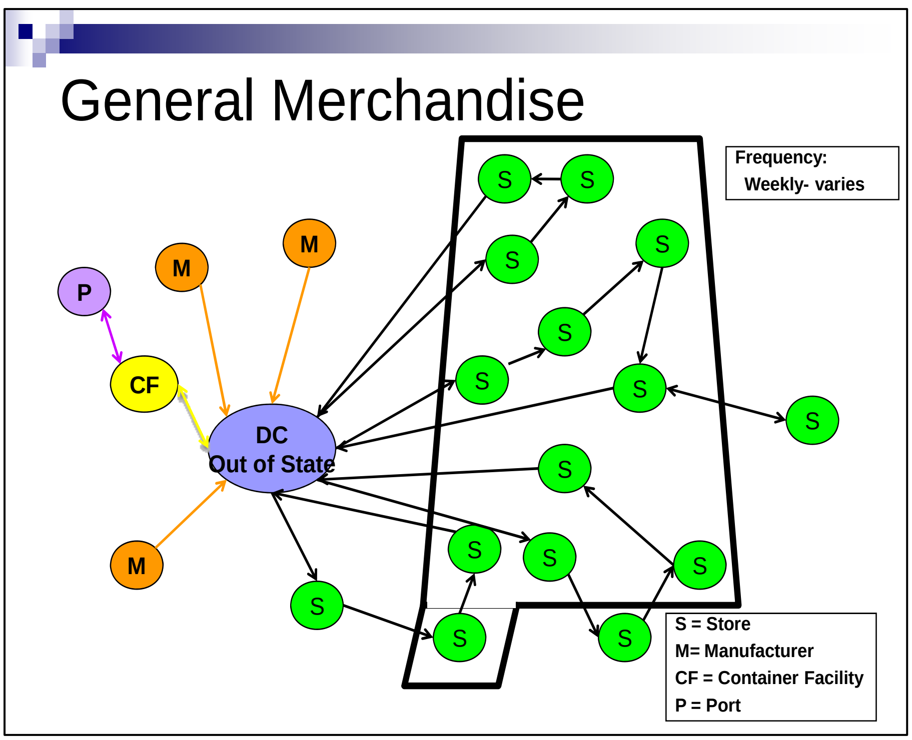


Figure 2.9. General Merchandise Distribution

Grocery Chains

Grocery store chains handle their freight similar to the super centers and drug stores. In fact, some may argue that the grocery store industry designed the transportation networks which have been adapted by the super centers, general merchandisers, drug stores and others. Grocery store chains have more segments of inventory as well as inventory managed by vendors. In broad terms, the sectors may be perishables, staples, and vendor managed inventory. The demand cycles and shopping habits of customers drive the delivery schedule for all of these items. The more frequently sold items like bread and milk, are delivered at least once each day while other perishable items like produce may be delivered one or two times per week. Vendor managed inventory such as soft drinks, beer, and snack food are delivered several times per week by a vendor representative. Additionally, local producers and growers may deliver items directly to the store. Grocery chain distribution centers are utilized to assemble products into shipments of the staple items not managed by vendors or delivered directly by manufacturers for each store. However, manufacturers that directly deliver to stores also deliver products to distribution centers which then ships small quantities to stores in their service region. The goals of maximizing freshness while minimizing transportation costs require a sophisticated logistics capability for grocery chains to be successful.

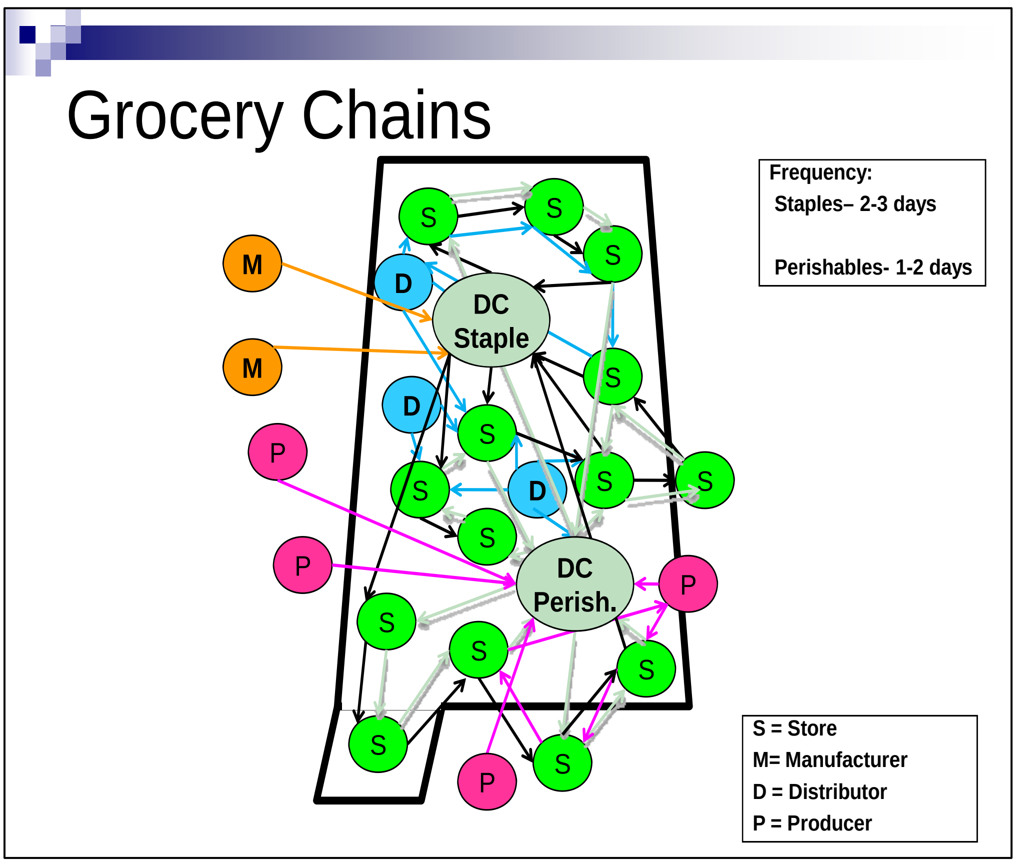


Figure 2.10. Grocery Chain Retail Distribution

Home Electronics

Home electronics and entertainment stores have also changed over the past couple of decades. The distribution strategy by major retailers of these products has shifted from the department stores to "big box" stores which specialize in home electronics and/or entertainment, especially in larger cities. With the emergence of these big box stores, regional distribution centers now supply stores in multiple states. The distribution centers supplying Alabama stores may be located two or three states away but shipments are delivered at each store several times each week, especially during peak (Christmas) season. Companies frequently own or lease the trucks on regular routes. Of course, manufacturers may deliver to both distribution centers and retail stores but the largest volume of these items come from offshore through a water or air port of entry. Container processing facilities can supply both the distribution center as well as retail stores. As with the fashion-based retailers, home electronics chains compete to be the "first" to offer or to have the "most" new products in order to capture market share. While inventory is carried at distribution centers, it is turned as frequently as possible. Build-up of inventory for peak season (Christmas) is sometimes necessary to meet anticipated seasonal demand. Freight is also moved between stores or backhauled to the distribution centers most often in company owned vehicles. Stores exclusively using common carriers or parcel services to ship freight to stores often will drastically mark down merchandise rather than pay to ship it to another store or the distribution warehouse.

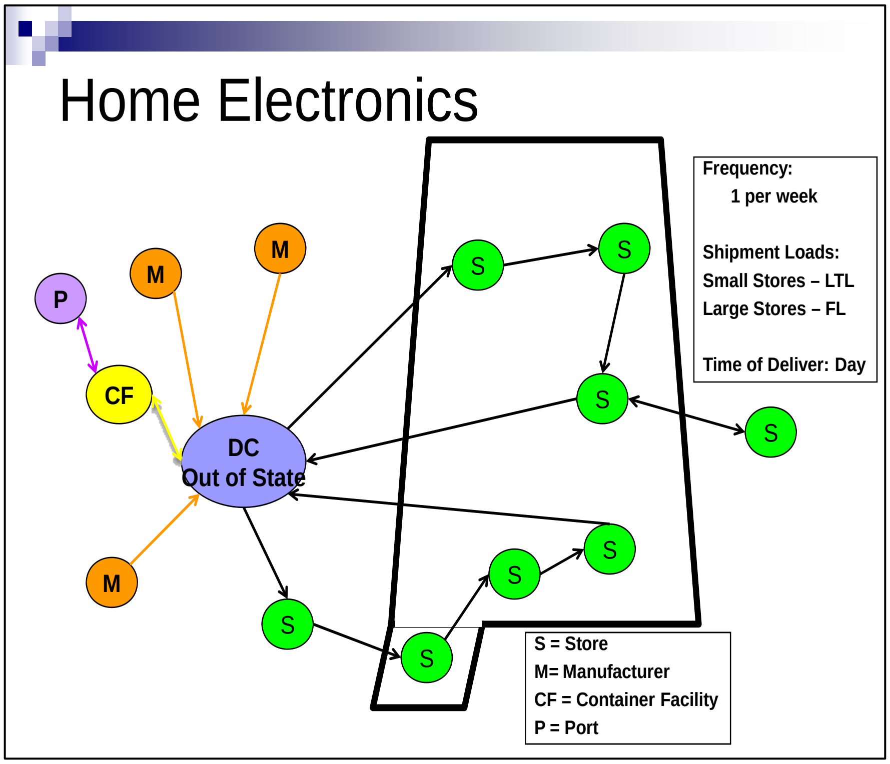


Figure 2.11. Home Electronics Retail Distribution

Sporting Goods

The sporting goods industry is similar to the home electronics industry sector in transportation network design except there is significantly more regional and seasonal adaptation of product lines in the retail stores. Seasonality is largely influenced by the seasons of major sports like football, baseball, basketball, soccer, etc. rather than simply a Christmas rush. However, sporting goods chains rely heavily on their distribution center(s) to serve very large regions of or the entire continental United States. Manufacturers deliver truckloads of product while common carriers deliver less than truck loads to the distribution center. Much of the inventory is imported through container ports with the transportation to the distribution center managed by the manufacturer. Product is then redistributed onto pallets or tubs which will be delivered to each store. Inventory usually remains in the distribution centers for no more than one week as weekly deliveries are made to each retail store. Seasonal peaks may require additional inventory but because of the geographic differences in sport seasons and products, i.e. hockey equipment is sold mostly in the colder climates, sporting goods stores are able to use smaller distribution centers to serve very large geographic areas.

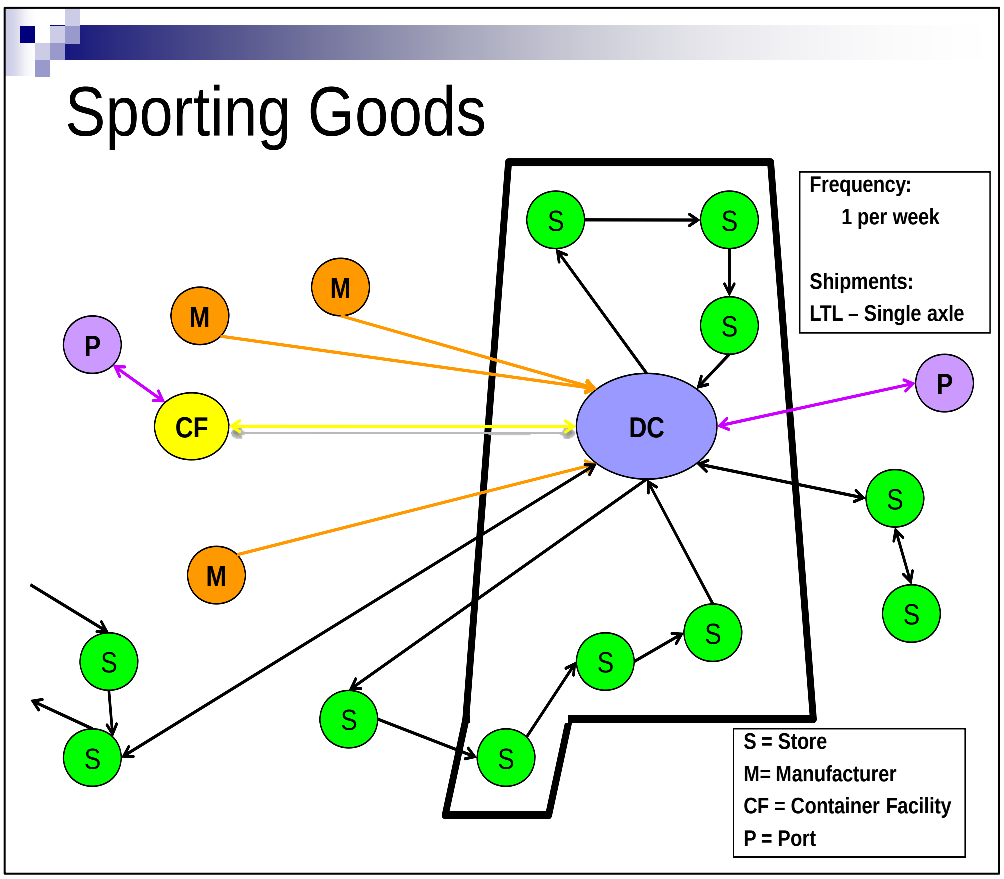


Figure 2.12. Sporting Goods Retail Distribution

Parcel Services

The parcel shipping services industry was redefined by Federal Express many years ago. Services have expanded from next day delivery specialization to ground freight to third party logistics. The parcel service companies consider their freight handling network to be a major competitive strategy that is to be protected and managed constantly. Because of the competitive nature of these companies, detailed information about their transportation network is very difficult to obtain. However by using secondary research coupled with telephone interviews, this very complex transportation network can be approximated to understand better an extremely important sector in the movement of final demand freight. By separating the inbound and outbound shipments to/from Alabama, it is easier to see how freight moves from source to destination.

Inbound freight can come into Alabama from many directions. Regional logistics hubs across the country provide links to local centers which send delivery trucks to businesses and residences. These logistics hubs may do routing of freight destined for areas within their regions without going through a major processing center. Shipments arrive at the logistics hubs from the processing center and other logistics hubs. For inbound freight, logistics hubs serve as connection points to the company's transportation network. From these connections, freight is loaded onto trucks running regular daily routes for delivery to the logistics hub and/or processing centers. Companies own and lease equipment (trucks, trailers, planes, etc.) as well as hire other carriers to move less than full load freight such as on international cargo flights. Local vans deliver the packages to customer locations (business and residence) on at least daily routes. Some routes may be run two or more times per day depending on volume and business density.

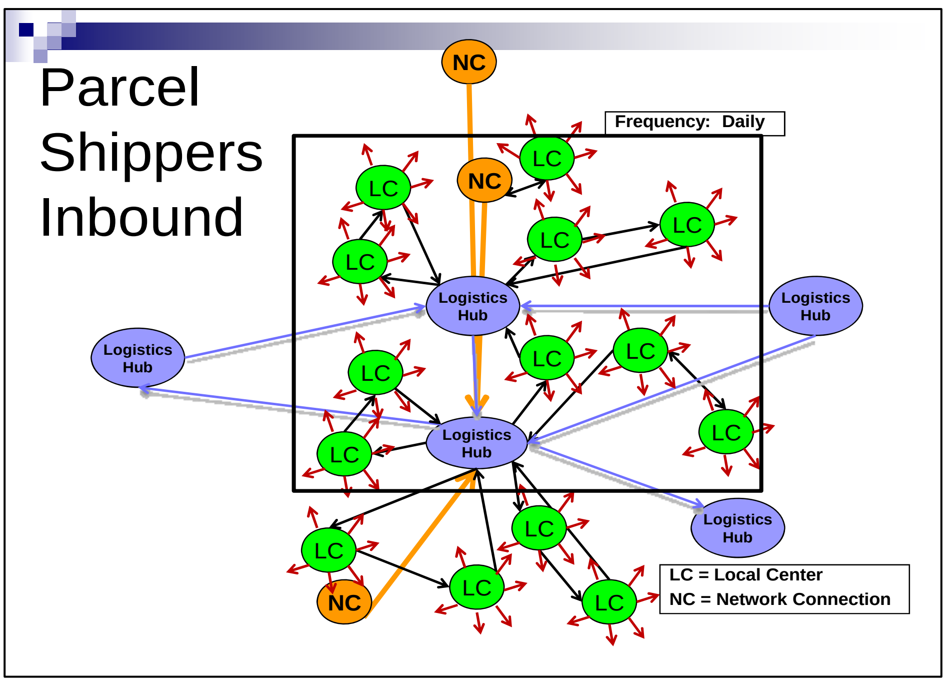


Figure 2.13. Parcel Shippers Inbound Distribution

Outbound freight leaves Alabama in a manner somewhat different than a simple reversal of the inbound network. For outbound freight, pickups are scheduled by the company or customers bring their shipments to the local center throughout the business day. The outbound freight is then sent to logistics hubs which become network collection points. These logistics hubs then separate freight into local zones and non-local zones as well as by package size/weight. Freight that is destined for zones in the local region is sent to the appropriate logistics hub by truck. Freight that exceeds size or weight limits for normal processing is handled through established truck routes between logistics hubs and/or the processing center(s). The overnight and normal size packages are collected at an airport serving the region (one state, multiple states, or partial states) and flown to the designated processing center each night. Network connections used for inbound freight may not be on the outbound freight network at all. This process repeats every business day around the world for major parcel shippers.

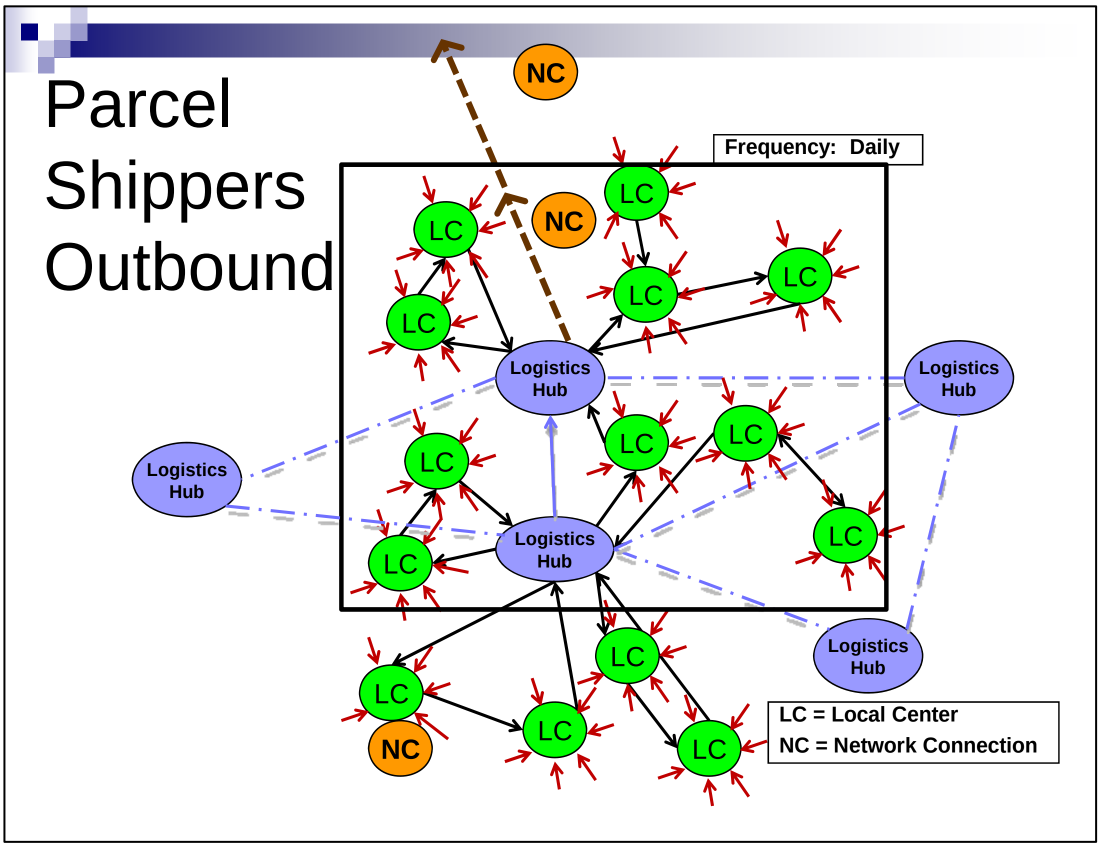


Figure 2.14. Parcel Shippers Outbound Distribution

In summary, each industry sector may have multiple transportation network designs built or adapted by individual companies. In almost all cases, transportation efficiency is measured in terms of total cost as well as elapsed-time. Companies that manage their freight transportation and logistics operations best usually have a competitive advantage over other companies. The growing global supply chain is changing the role of distribution centers and in many cases changing the routing of goods to their retail stores.

2.3 Create a methodology to identify destinations for distribution centers using an industry database - Task 4

Jeff Thompson served as the lead for this task which was to create a methodology to identify destinations for distribution centers using an industry database. The original intent of this task was to use input from distribution center surveys conducted in Task 2 & 3 to build a database by type of industry sector. This information would then be used to improve projections of freight transportation volumes. As the surveys were conducted, it became very clear that there were few, if any common, characteristics for distribution centers even within industry sectors. In other situations, obtaining information from the distribution centers serving Alabama was not possible due to either proprietary issues by the companies or due to their distant location. However, seven characteristics emerged which may be helpful in better representing final demand freight in transportation forecasting models. The characteristics are identified in the listings below:

- Type of Network
- Primary Mode Choice
- Type of Management the Transportation Network
- Origin of Distribution Center Freight
- Destination of Final Demand Freight
- How Freight Shipments are Built
- Whether Back Haul of Freight is Common
- Frequency of Shipment Delivery to the Retail Stores

Network type typically fell into one of two categories: hub and spoke or route-based. There were, however, some sectors that employed a combination of the two. In these cases, the type used most in their network design is identified in the Distribution Center Freight Networks summary table below. Five of the sectors predominately used a hub and spoke design with their distribution center being the hub. Six of the sectors sampled largely used a route-based network to move freight from one or more points of origin.

The primary transportation mode of choice for all final demand freight is by truck. A few sectors rely heavily on rail or air to move freight to or from their distribution centers. The final leg of the shipment to retail stores is always by truck or van. One surprising observation was that tractor trailers are now being frequently used to make deliveries to retail stores even for very small stores that always received less than trailer loads.

The type of management strategy used by companies varies for many reasons such as industry custom, proximity to shipment origins, growing product imports, and time efficiency. Companies may own or lease a fleet of trucks, rely on common carriers, insist on manufacturer delivery to their dock, or hire third party logistics providers to handle freight. Intermodal container processing centers are important links in retail supply chains as more products are imported.

Table 2.3. Distribution Center Freight Networks by Sector

Distribution Center Freight Networks

Industry Sector	Network Type	Primary Mode Choice	Manage-ment Type	Dist. Ctr. Freight Origin *	Freight Destination	Shipment Build	Back Haul	Frequency
Beverage Distributors	Hub	Truck	Manufac.	M,D,CF	Retail Store	Product Group	n/a	Weekly
Big Box Centers	Hub	Truck	Own/ Lease	M,D,CF, IM	Retail Store	Product Group	n/a	Weekly
Furniture	Hub	Truck	Own/ Lease	M,D,CF	Residence	Geography	n/a	Weekly
Fuel Distributors	Hub	Truck	Multi	Terminal	Retail Store	Product Group	n/a	1-2 Days
Pharmacies	Hub	Truck	CC, 3PL	M,D	Retail Store	Product Group	Stock	Daily
Automobiles	Route	Truck/Rail	Carrier	M,IM	Retail Dealer	Product Group	Stock	2-3 Weekly
General Merchandise	Route	Truck	Own/ Lease	M,D,CF	Retail Store	By Store	Stock	Weekly
Grocery Chains	Route	Truck	Manufac.	M,D,W	Retail Store	Product Group	n/a	1-3 Days
Home Electronics	Route	Truck	Own/ Lease	M,D,CF	Retail Store	By Store	Stock	Weekly
Sporting Goods	Route	Truck	Own/ Lease	M,D,CF	Retail Store	By Store	Stock	1-2 Weekly
Parcel Services	Route	Truck/Air	Own/ Lease	n/a	Residence	Route	Outbound	Daily

* M=Manufacturer D=Distributor, CF=Container Facility, IM=Intermodal, W=Warehouse

Inbound freight to distribution centers can originate at manufacturers, distributors, container processing centers and intermodal facilities. Geographic location expressed in units of time rather than distance greatly influences how shipments arrive at distribution centers. Additionally, the goal of shortening the supply chain to the retail store as well as reducing inventory levels significantly influence the scheduling of receipts and outbound shipments at distribution centers.

Freight destination was an unexpected characteristic in that the distribution centers are no longer only supplying retail stores but increasingly fill orders delivered directly to the customer. The furniture sector appears to be a leader in using this model outside of the parcel services companies.

Shipments from distribution centers are built by store or by product group. The products handled at some distribution centers are segmented based on the product handling requirements as well as regional territories. These roles may be defined differently by each company even within the same sector.

The type of freight moved in distribution center backhaul legs was found to include not only company inventory but also inbound freight from manufacturers/distributors. Each company or freight transportation provider seeks to minimize unused trailer capacity on each leg of their routes. Empties are seen as very costly as well as opportunities to expand the capacity of a network.

Deliveries to retail stores appear to be increasingly more frequently with smaller less-than- trailer loads even as routes are growing longer. Restrictions on the time of day that deliveries can be made to retail stores are even more important as larger trucks are used for relatively small shipments. However, frequency of delivery is more uniform across industry sectors with a few shipments from the distribution center each week being the norm. This frequency appears to be a requirement in the design of distribution networks by most transportation network managers.

2.4 Create a methodology to project final demand in Alabama by destinations - Task 5

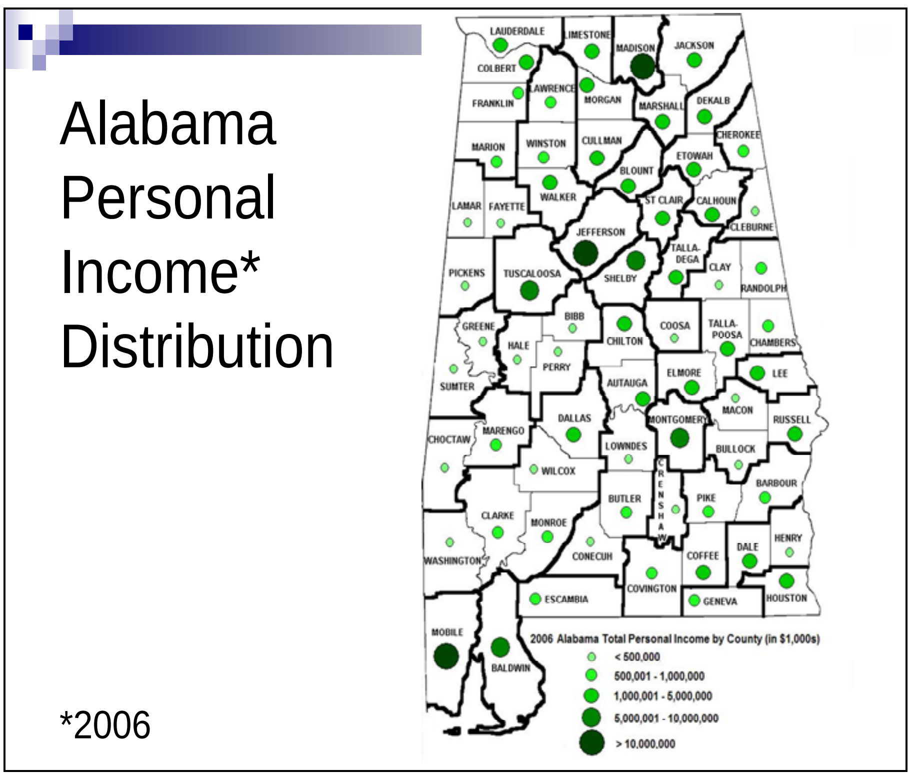
Niles Schoening, Ph.D., served as the lead for this task which entails the creation of a methodology to project final demand in Alabama by county. A basic assumption was made which is that final demand freight is a function of local consumer demand. The challenge became one of identifying one or more factors that could represent consumer demand at the county level that were collected often and originated from a reliable source.

Demand variables of population size, personal income and a combination of population & personal income were analyzed through the transportation forecasting model. The population size alone skewed the freight too heavily to major cities while somewhat ignoring consumer demand in the rural parts of the state. Population & personal income together likewise appeared to centralize freight too heavily in high density areas of the state. Personal income alone, while not perfect, correlated better with expected final demand freight distribution across the state. Regional differences in personal income exist but to a lesser degree than population differences.

Using the industry sector distribution center surveys as representative of the entire sector was not feasible due the wide variation of freight transportation networks within industry sectors. Instead, Alabama data was extracted from the FAF2 database and then allocated to freight analysis zones, determined by cluster analysis approach by the research team. The freight in each zone was allocated to each of the counties in the zone based on its personal income level.

In Figure 2.15 below, a map of Alabama highlights the distribution level of personal income by county in 2006.

Figure 2.15. Alabama Income Distribution by County for 2006



The multi-step process of allocating shipments first to freight zones and then to counties produced reasonable results that can be repeated as final demand freight volumes change and/or personal income levels change. Personal Income is estimated and projected in a number of third party economic forecasts models each year.

A major challenge with this approach is that retail centers for multiple county regions may not get a larger share of the freight shipments than the surrounding counties where there are relatively fewer retail stores but higher personal income. Examples of this can be seen in the relationship between Jefferson and Shelby counties as well as between Baldwin and Mobile counties. Since the personal income is calculated based on place of residence, refinements to the personal income factors need to be evaluated.

2.5 Future Enhancement Opportunities

There are a number of alternatives and/or enhancements to the approach developed which may improve forecasting of final demand freight at the local level. These include: (1) more localized (e.g., metropolitan statistical area or county level) economic forecasting instead of relying on state-level economic forecasts for growth, (2) using a larger sample size for the industry sectors, (3) estimating economic impacts of new and future economic development announcements, and (4) better understanding the impact of improved commuter transportation infrastructure on retail shopping behavior. These and other enhancements should be analyzed in future research on forecasting final demand freight.

3. Pass-through Freight Modeling

The efficient and effective movement of freight is a critical component in the transformation and growth of the economy. The ability to predict freight transportation requirements is vital to planning the necessary infrastructure improvements that can ensure congestion along a state's highways does not lead to a reduction in economic development (1). Transportation models must include predictions of freight movements. The freight predictions include those internal to the study area, those that either are attracted to or originate from the study area and those external to the study area that are a result of the freight passing through. The trips that have either the origination or destination in the study area are easier to model because the industries or retail outlets responsible for the freight activity are located in the study area and can be surveyed to determine the volume of freight flows produced or attracted. The freight trips that are external to the study are more difficult to model because the planner is not able to survey industries or retail outlets that produce or attract the freight. The difficulty with obtaining this critical data has been identified in research performed on other statewide models and guides that indicate a trip exchange table for external-external freight transportation is necessary, but no clear guidance is provided to develop the trip table (2).

This section of the report focuses on the development of tools and procedures to utilize the Federal Highway Administrations (FHWA) Freight Analysis Framework, Version 2 (FAF2) database to forecast and model pass-through freight. The tools and procedures will be designed and built using national, statewide and local levels for analysis. This chapter first presents work performed to determine pass-through freight for the entire state using a national level approach. The chapter then focuses on the development of a statewide freight flow model for Alabama that can then bring the pass-through to the local level. Finally, this chapter concludes with an analysis of pass-through freight at the MPO level.

3.1 FAF2 Data

The accuracy of any modeling activity is based on the quality of data entered into the process. For freight applications, the best data that is currently available is the Federal Highway Administration's Freight Analysis Framework (FAF) database.

The second generation of the Freight Analysis Framework (FAF) known as FAF2 is a continuation of the original Freight Analysis Framework developed by the U.S. Department of Transportation, Federal Highway Administration (FHWA) (4). Whereas the original FAF provided the public with generalized freight movement and highway congestion maps without disclosing the underlying data, FAF2 provides a commodity flow origin-destination (O-D) and freight movement data on all highways within the FAF2 highway network. The FAF2 Commodity Origin-Destination Database estimates tonnage and value of goods shipped by type of commodity (Table 3.1) and mode of transportation (Table 3.2) for 114 FAF2 zones (shown in Figure 1), 7 international trading regions and 17 additional international gateways, (3). The 2002 estimate is primarily derived from the Commodity Flow Survey (CFS) with some of the data voids in the CFS filled in by analysis of the Economic Census and other data sources. Forecasts are included for 2010 to 2035 in 5-year increments (3). The data are available in Microsoft Access format and contain values in million of dollars of value and thousands of short tons.

Table 3.1. Listing of commodities on FAF2 database (5)

BTS/Census Full Commodity Name	FAF Abbreviation
Live animals and live fish	Live animals/fish
Cereal grains	Cereal grains
Other agricultural products	Other ag prods.
Animal feed and products of animal origin, n.e.c.1	Animal feed
Meat, fish, seafood, and their preparations	Meat/seafood

Milled grain products and preparations, bakery products	Milled grain prods.
Other prepared foodstuffs and fats and oils	Other foodstuffs
Alcoholic beverages	Alcoholic beverages
Tobacco products	Tobacco prods.
Monumental or building stone	Building stone
Natural sands	Natural sands
Gravel and crushed stone	Gravel
Nonmetallic minerals n.e.c.1	Nonmetallic minerals
Metallic ores and concentrates	Metallic ores
Coal	Coal
Crude Petroleum	Crude petroleum
Gasoline and aviation turbine fuel	Gasoline
Fuel oils	Fuel oils
Coal and petroleum products, n.e.c.1 (Note: primarily natural gas, selected coal products, and products of petroleum refining, excluding gasoline, aviation fuel, and fuel oil.)	Coal-n.e.c.1
Basic chemicals	Basic chemicals
Pharmaceutical products	Pharmaceuticals
Fertilizers	Fertilizers
Chemical products and preparations, n.e.c.1	Chemical prods.
Plastics and rubber	Plastics/rubber
Logs and other wood in the rough	Logs
Wood products	Wood prods.
Pulp, newsprint, paper, and paperboard	Newsprint/paper
Paper or paperboard articles	Paper articles
Printed products	Printed prods.
Textiles, leather, and articles of textiles or leather	Textiles/leather
Nonmetallic mineral products	Nonmetal min. prods.
Base metal in primary or semi-finished forms and in finished basic shapes	Base metals

Articles of base metal	Articles-base metal
Machinery	Machinery
Electronic and other electrical equipment and components and office equipment	Electronics
Motorized and other vehicles (including parts)	Motorized vehicles
Transportation equipment, n.e.c.1	Transport equip.
Precision instruments and apparatus	Precision instruments
Furniture, mattresses and mattress supports, lamps, lighting fittings	Furniture
Miscellaneous manufactured products	Misc. mfg. prods.
Waste and scrap	Waste/scrap
Mixed freight	Mixed freight
Commodity unknown	Unknown

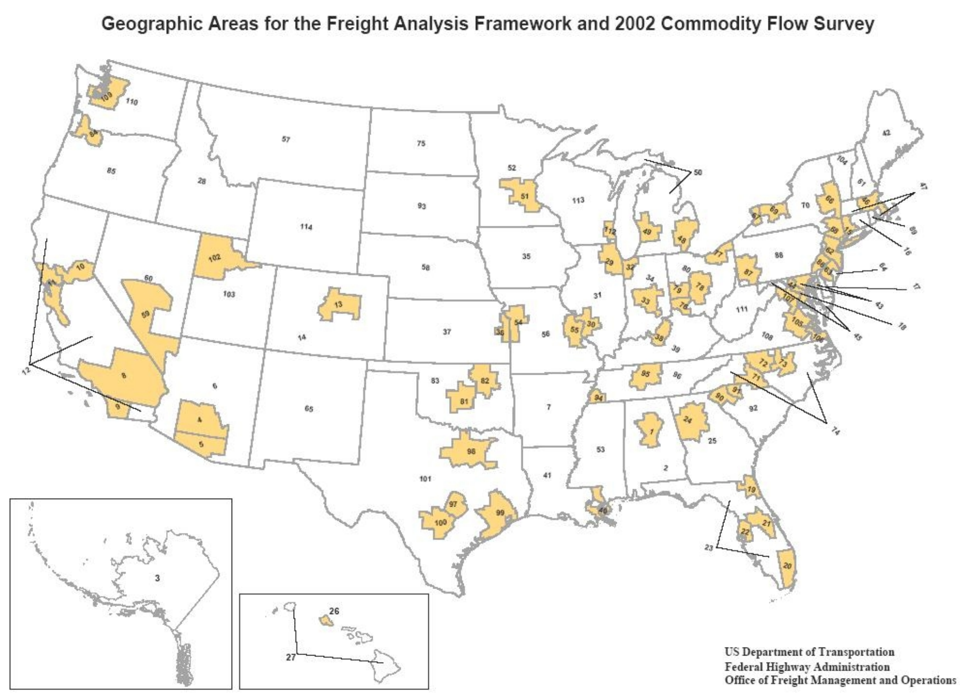


Figure 3.1. Geographic locations for FAF2 data (6)

Table 3.2. Listing of Transportation Modes from FAF2 (6)

Truck. Includes private and for-hire truck. Private trucks are operated by a temporary or permanent employee of an establishment or the buyer/receiver of the shipment. For-hire trucks carry freight for a fee collected from the shipper, recipient of the shipment, or an arranger of the transportation.
Rail. Any common carrier or private railroad.
Water. Includes shallow draft, deep draft and Great Lakes shipments. FAF2 uses definitions by the U.S. Army Corps of Engineers. Shallow draft includes barges, ships, or ferries operating primarily on rivers and canals; in harbors; the Saint Lawrence Seaway; the Intra-coastal Waterway; the Inside Passage to Alaska; major bays and inlets; or in the ocean close to the shoreline. Deep draft includes barges, ships, or ferries operating primarily in the open ocean.
Air (includes truck-air). Includes shipments by air or a combination of truck and air. Commercial or private aircraft and all air service for shipments that typically weigh more than 100 pounds. Includes air freight and air express.
Truck-Rail Intermodal. Includes shipments by a combination of truck and rail.
Other Multiple Modes. Includes shipments typically weighing less than 100 pounds by Parcel, U.S. Postal Service, or Courier, as well as shipments of all sizes by truck-water, water-rail, and other intermodal combinations.
Pipeline and Unknown. Pipeline is included with unknown because region-to-region flows by pipeline are subject to large uncertainty.

3.2 Statewide Pass-Through

The initial level of analysis undertaken in this work was to focus on the statewide level of national pass through freight. This freight was essentially comprised of those movements where Alabama was in the unfortunate position of being between origin-destination locations, but the freight activity in no way was primary to Alabama. An example of this freight pass-trough would be freight traveling from South Carolina to Louisiana. Alabama in not primary to this freight movement, however, this freight movement would impact travelers in Alabama and consume roadway capacity within the state and MPOs.

The methodology to develop the external-external table from the FAF2 database is comprised of the following steps:

1. Develop a national travel demand network that includes all 114 zones defined by the FAF2 database.
2. Perform a select link analysis technique in a commonly used travel demand model to determine which origin/destination pairs use roadways in the desired study area or state.

3. Extract the relevant data from the FAF2 database based on the O/D pairs obtained in step 2, either in dollar value of shipment or tons shipped,.
4. Use the O/D pairs and data in a travel forecasting model to determine external-external trips.

The steps listed above are explained in further detail in the following sections.

Create a National Network

The national network is designed to provide a basis for using a travel demand software package to determine the external-external traffic flows. The creation of the network involves the development of zones and roadway infrastructure similar to what would be performed to develop a traditional urban planning model. Any travel demand software can be used to create the network and run the model.

The FAF2 data structure defining the 114 zones (Figure 3.1) of freight origin and destination should serve as the base zone structure for the travel demand model network. To improve the analysis, a geographic file that contains the 114 regions can be downloaded from the FAF2 website (3). This geographic data is intended to be the starting point for the analysis.

The roadway network developed serves as the connection between the zones. The travel demand network should include roadway distances, travel speeds and capacities. To assist in the analysis, a geographic file containing transportation infrastructure is available for download from the FAF2 website (3).

Perform Flow Analysis

After the national infrastructure network has been developed, a flow analysis is performed to determine the travel patterns and identify which O/D pairs utilize the roadways in the area or state of interest. This can be accomplished through various methods based upon the travel demand model being employed for the study. Traffic must be assigned from each zone independently and the path to the other 113 destination zones can be determined. The O/D pairs that use roadways in the area or state of interest can then be identified. The O/D pairs that use the roadways in the study area or state can then be used in the analysis.

Run Computer Program to Extract Data

After the O/D pairs that traverse the area or state of interest are determined in task 2, the FAF2 database must be reduced to contain only data for the O/D pairs of interest. To assist this step, researchers at the University of Alabama in Huntsville, Office for Freight, Logistics and Transportation developed a computer program in C++ that allows the user to input the relevant O/D pairs in a text file. The program generates an external-external table for the area or state in either the value of shipment in dollars or tons shipped.

Assign Data to National Network

Once the external-external data is developed, the user must assign the data to the national network. The assignment should be performed using the travel demand model and the user defined assignment procedure. This will allow for the analysis of external-external value of shipment or tons shipped to be assigned to the travel demand network. The assignment must be converted to the number of vehicles to be used for modeling purpose. The conversion factors for turning value of shipments or tons shipped into an accurate number of vehicles for each commodity and mode are critical to the freight planning process, and are of great concern, but is the subject for a future research paper.

The development of the external-external data and assignment can be accomplished by performing the steps of the methodology presented above. Planners can use the process described to create the data for the base level of freight traffic on the transportation facilities in their area of concern, whether local or statewide.

3.2.1 Statewide Alabama Pass-through

To demonstrate the application of the methodology, an analysis of the external-external (pass through) data was performed for the state of Alabama. Included in the case study description is increased detail and documentation of specific steps when using TRANPLAN, which is the travel demand model used in Alabama.

The first task was the development of the national network. The FAF2 website provides a starting point by providing a national infrastructure. The infrastructure, in ArcGIS format, was downloaded and is shown in Figure 3.2. From this data, the Interstate routes were highlighted and used to create a national network to connect the zones defined in the FAF2 database (Figure 3.3). The national network was developed using CUBE-TRANPLAN, the travel demand model currently being used in Alabama for transportation forecasting. The national network was comprised of 114 zones (as defined by the FAF2 regions), nodes to reflect intersections and links to serve as roadways. The roadway was manually developed and the nodes and links were drawn using a “heads-up” digitizing technique with the ArcGIS file serving as an image layer to ensure the roadways were spatially accurate. Attributes were applied to the network such as roadway distances, speed limits and capacities. However, as the use of the network was to determine shortest path between zones, flows were not constrained by capacity.

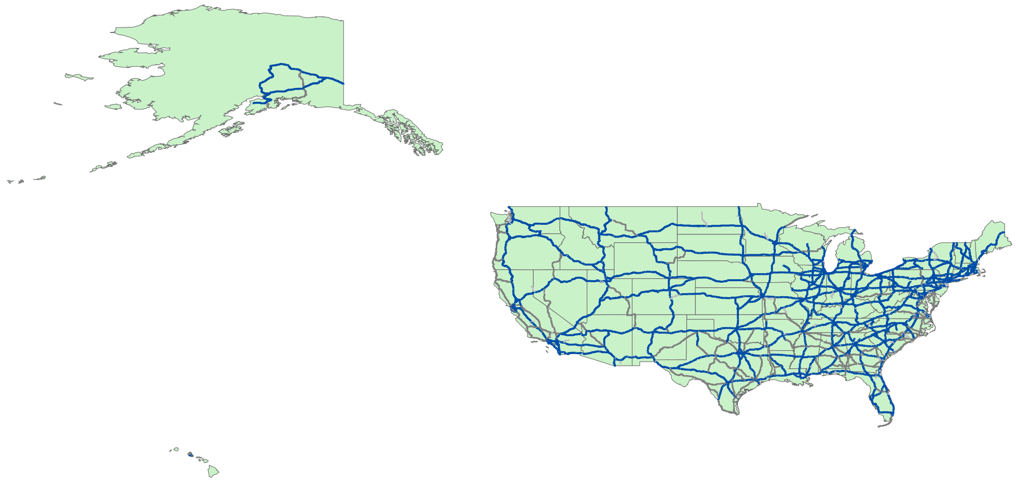


Figure 3.2. Roadway infrastructure from FAF2

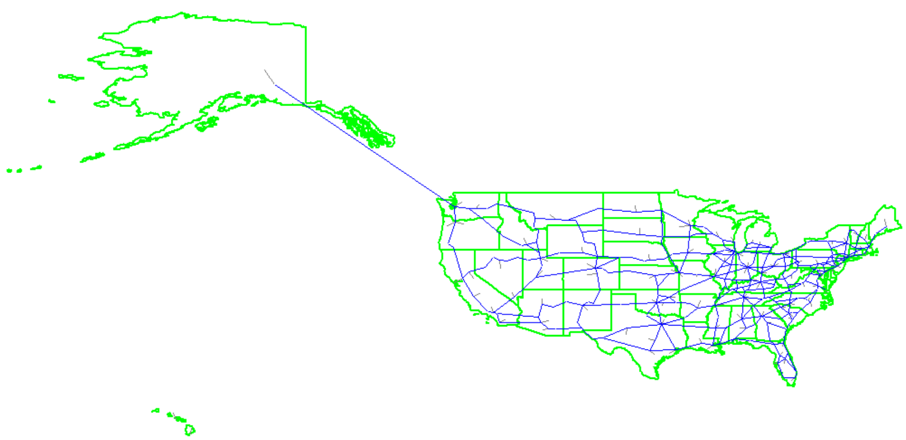


Figure 3.3. National Network in CUBE-TRANPLAN format

A variety of CUBE-TRANPLAN modules were used to develop the flow analysis and define the shortest path through the national network between zones. Initially, the network was input to the Highway Selected Summation module to determine the skims, or the shortest path between all 114 zones. Then, the skims were entered into a gravity distribution model, Gravity Model, with a fictitious production and attraction file. The production and attraction file was established with 100,000 productions and attractions for each zone – essentially a large value to ensure some trips would be distributed between each zone pair. Next, a fictitious assignment was performed to utilize the roadway network and place traffic on the roadways utilizing Load Highway Network. The assignment was performed using a shortest path methodology directing all traffic on to the shortest route, regardless of congestion. Finally, the Load Highway Selected Links module was used to extract specific route information.

Using the Load Highway Selected Links module, it was possible to identify selected roadways where only the traffic using the selected roadways would be included in the output. It is possible to identify a collection of links where the travelers have to use all the links identified or only one of the links identified. For Alabama, seven roadways that represented interstates crossing state lines were identified as the selected links. The rule was established that the traffic only needed to use one of the links to be included in the results. In addition, the module allows for the identification of origin locations, destinations locations or a combination of both be identified to limit the amount of traffic stored. In the analysis, as the values external to Alabama were of interest, the origin zones were varied individually from zone 3 – Alaska to zone 114 – Wyoming. Zone 1 and 2 were excluded from the study because they are internal to Alabama. Figure 3.4 presents the shortest paths from Zone 21 – Orlando, FL to all other zones, if the shortest path crosses through Alabama.

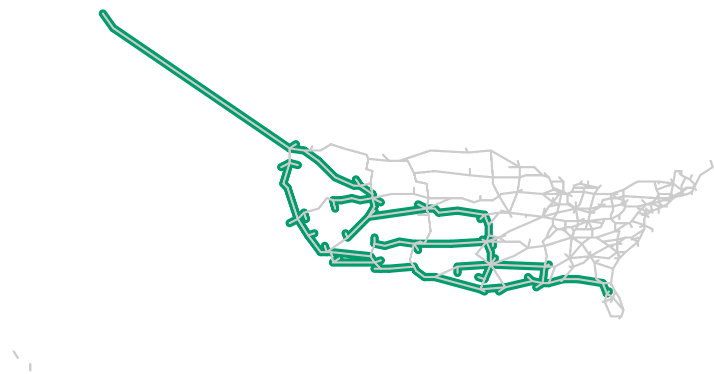


Figure 3.4. Shortest path from Zone 21 through Alabama

During the process of running the Load Highway Selected Links for each origin, the output network containing the paths that pass through Alabama were exported to ArcGIS for further analysis. A query was developed to show the destination zones that were on the path through Alabama. The main interest in this step was the development of paths from a single origin to multiple destinations. These values were recorded in a spreadsheet and saved as tab delimited text file. The values, formatted to show the origin zone number, destination A zone number, destination B zone number, destination C zone number, etc., were saved for input into the computer program written to extract the FAF2 data.

After developing the origin destination pairs traffic passing through Alabama would use, the next step was to extract the FAF2 data from its native Microsoft Access Database format into a text file. The planner could use the FAF2 data for either 'Kilotons' or 'Millions of Dollar Shipped'. The two text files serve as input to the computer program written to extract the data. The flowchart for the program developed at UAH is shown in Figure 3.5.

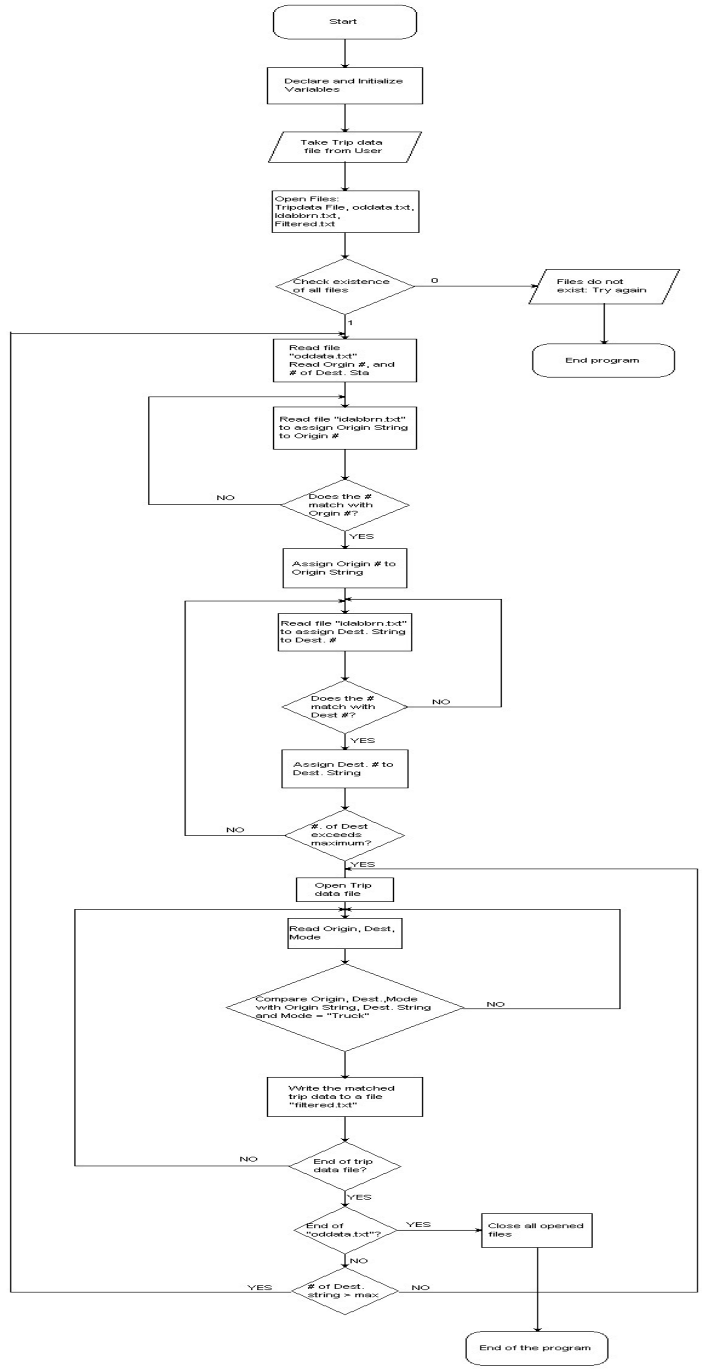


Figure 3.5. Flowchart of the FAF2 Data Extraction Program

The FAF2 Data Extraction Program creates a text file containing origin, destination and FAF2 value for each commodity listed in the database. In addition, as a parameter input into the program, a search is performed during the operation of the program to extract only data for which “truck” is listed as the mode of transportation. It is important to note, that if the infrastructure were developed for alternative modes, the program could be easily modified to extract rail or water shipment data if the origin destination zones were also adjusted to reflect the alternate mode.

The output from the program is a text file that contains origin zone number, destination zone number, and FAF2 data value, either ‘Kilotons’ or ‘Millions of Dollar Shipped’, for each commodity in the FAF2 database. Once developed, a TRANPLAN routine was employed to convert the text file into a trip table for entry into CUBE-TRANPLAN. The trip table file is then input to the Load Highway Network module with the national network, to assign the ‘Kilotons’ or ‘Millions of Dollar Shipped’. Figure 3.6 illustrates two commodities assigned to the national network that pass through Alabama.

The validation of the methodology is difficult because the FAF2 data does not contain vehicle traffic. However, it is possible to perform a limited validation of the methodology. The validation technique involves comparing the tons of freight passing in and out of Alabama to the truck traffic crossing the state line to determine if the values violate truck weight laws, or not.

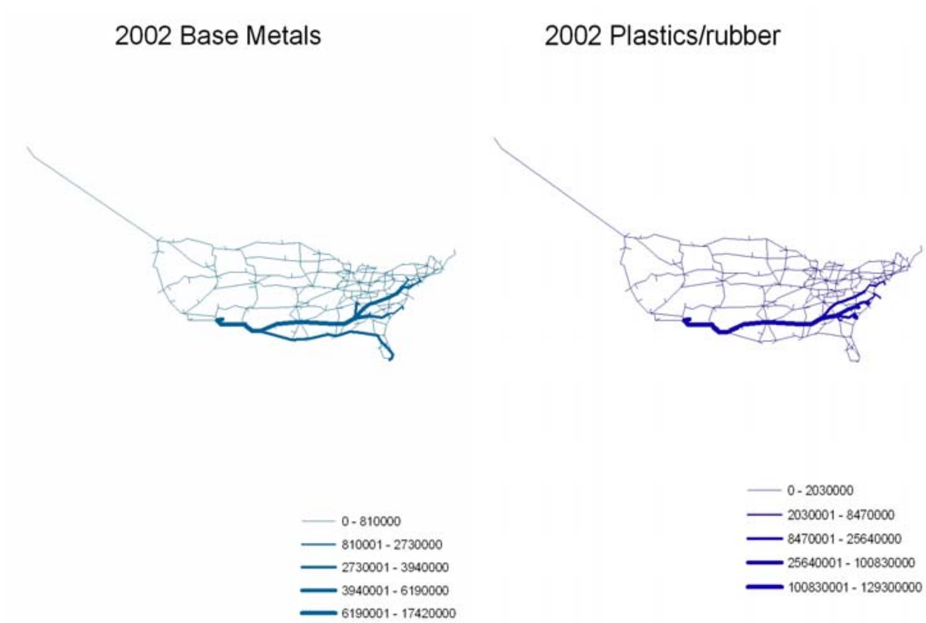


Figure 3.6. Assigned value of kilotons passing through Alabama

The assignment by commodity of the external kilotons to the national network is intended to provide a measure of the pass through traffic. However, it is still necessary to collect the internal-external and external-internal traffic for Alabama since these trips also pass across the state line. The values of kilotons that have either the origin or destination in Alabama are obtained from a direct export from the FAF2 database. The data exported can be sorted and purged such that only those that have their origin or destination in Zone 1 or Zone 2 (Alabama) and sorted by individual commodities to remove all the values that are not moved by “truck”. The TRANPLAN routine can be run to create a trip table for entry into the CUBE-TRANPLAN Load Highway Network module. Figure 3.7 shows the flow from the FAF2 database of all kilotons moved across the Alabama state lines.

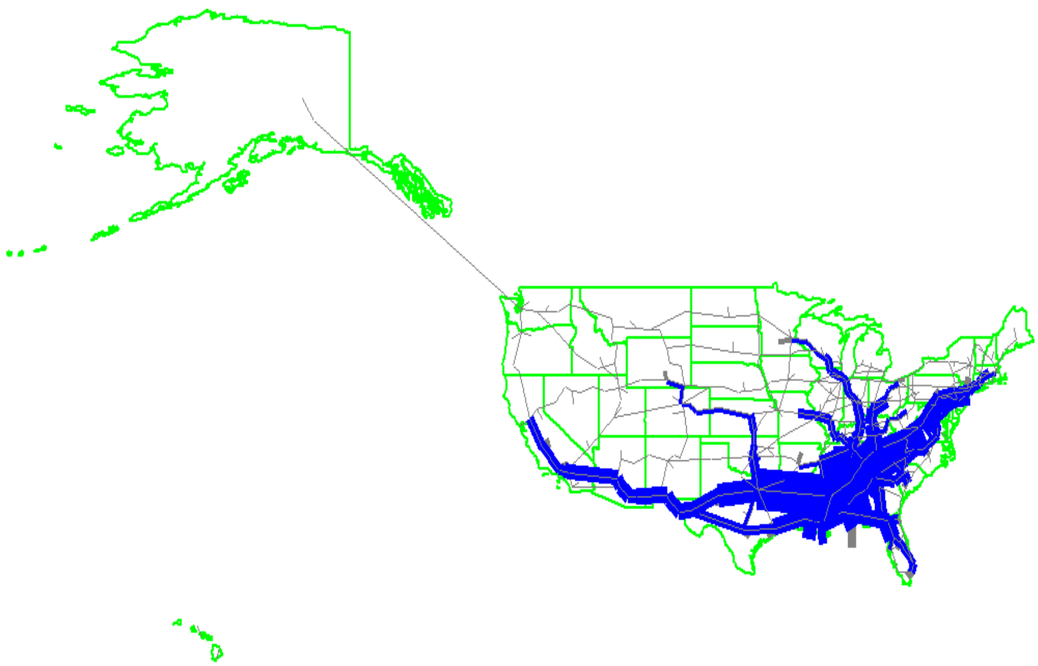


Figure 3.7. Kilotons of freight moved from, destine to, or through Alabama

A collection of the Kilotons crossing the state lines was then compared to the total truck count at the state line interstate locations. The Alabama Department of Transportation (ALDOT) provided the data related to truck counts. Table 3.3 presents the number of trucks per day reported by ALDOT crossing the Alabama state line. Table 3.3 also contains the tons of freight per year obtained from the FAF2 database that the methodology suggests crosses the Alabama state line. A comparison of the results indicates that the values obtained by calculating the weight per truck are realistic. The differences in truck weight are associated with the wide variety of commodities shipped via truck across the state lines and the distribution of destinations for those specific commodities.

Table 3.3. Method Validation

	Trucks/day (7)	Tons/year model	Tons/day	Tons/truck	Pounds/ truck
I65	7,768	52,071,250	142,661	18.37	36,730
I59	4,758	47,408,170	129,885	27.30	54,601
I20	14,531	38,163,040	104,556	7.20	14,390
I85	6,070	42,259,400	115,779	19.07	38,149
I10E	6,334	13,234,480	36,259	5.72	11,450
I10W	9,979	22,101,760	60,553	6.07	12,136
I59W	8,875	107,198,800	293,695	33.09	66,188

The application of the methodology for statewide modeling of pass-through freight is evident thought the use of the forecasted volumes from the FAF2 database. Using the forecasts included with the database and the national networks developed as part of this research, it was possible to obtain a level of pass through freight expected on each major interstate roadway in Alabama for any year in the FAF2 database, year 2010 and 2035 are shown. Additionally, the volume of pass-through freight can be shown for each year, assuming a value of 16 tons per truck. It is important to note at this point that the successive values for increases in pass-through freight are adjusted for the addition of Interstate 22, scheduled to be completed between the 2010 and 2015 forecast.

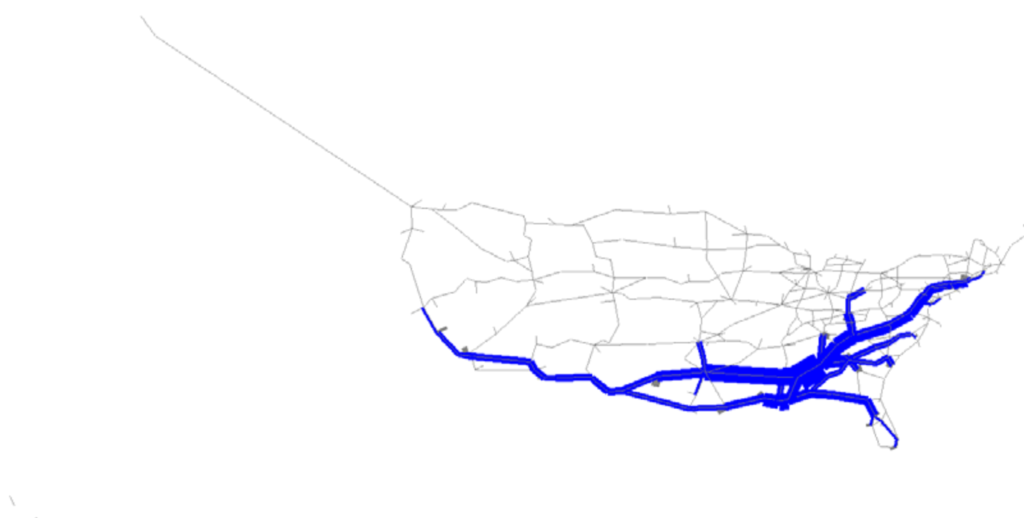


Figure 3.8. Pass-through freight for 2010

Figure 3.9. Pass-through freight for 2035

Table 3.4. Volume and expected number of pass-through trucks statewide

Year	Trucks
2010	18,258
2015	20,071
2020	22,485
2025	25,799
2030	30,151
2035	35,554

The number of trucks can be determined for specific MPOs, located on interstate facilities, from this analysis. For example, the Montgomery MPO will have to plan for almost 1,650 trucks passing through the study area between Interstate 85 to Interstate 65 in downtown Montgomery. This is not including the amount of trucks that will be on the interstate associated with trips that originate/terminate within Alabama.

Additionally, the FAF2 data can be used to evaluate the pass-through truck volumes resulting from the port of Mobile on the state and MPOs within the state. Through modeling the port facility separately, it can be seen that there is significant volume of freight moving by truck that is destine for locations outside Alabama and freight is generated outside Alabama destine for the Port of Mobile. The following Figure 3.10 outlines this freight.

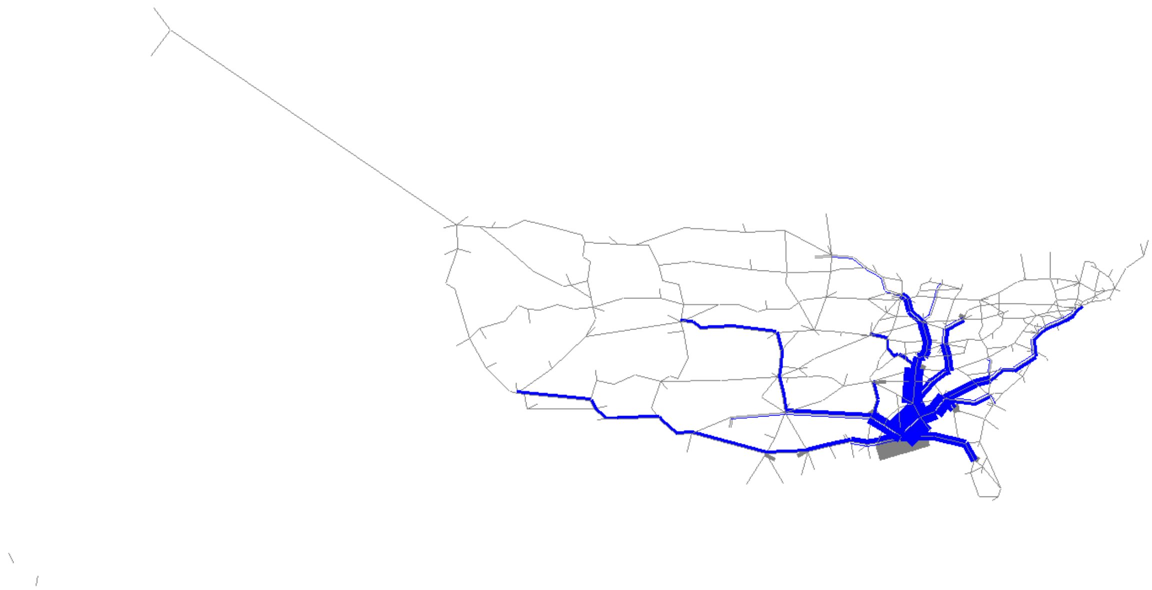


Figure 3.10. Port of Mobile impact on pass-through freight 2010

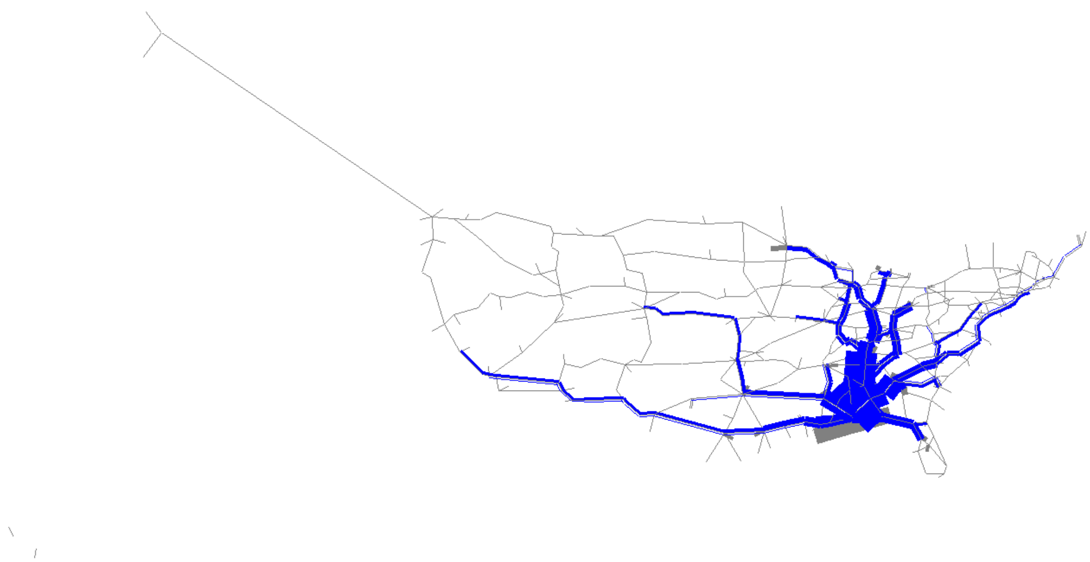


Figure 3.11. Port of Mobile impact on pass-through freight 2035

Examining the volumes passing-through the Montgomery MPO from the Port of Mobile, in 2010 the number of daily truck passing through Montgomery on Interstate 65 is 168 trucks per day and the number of daily trucks passing through Montgomery using Interstate 85 and Interstate 65 is 118 trucks per day. In 2035, the number of truck per day on Interstate 65 passing through Montgomery increases to 304 and the number of trucks per day on Interstate 85 and Interstate 65 is 190. Again, these trucks need to be accommodated in the planning process, but are not under the control of the local MPO.

The methodology presented in this section of chapter 3 focuses on a means to utilize FAF2 data to estimate statewide external traffic levels. The results of using the methodology produce a reasonable value of weight per truck for each interstate route as it crosses the Alabama state line. Additional use of this methodology would be a forecast of future years freight tonnage provided in the FAF2 database. Then, the application of a reasonable number of trucks to transport the total tonnage of freight could be ascertained to develop a future freight external flow value.

This methodology has been developed to be applicable to any state, or region identified in the FAF2 zone structure. Future improvements of the methodology would include developing truck weight factors for specific commodities and advancements in disaggregating the FAF2 database to a sub-state level. The method presented here improves the ability of transportation planners to quantify the base level of freight traffic in their area of concern. The base level of freight traffic contributes to total roadway congestion, but is difficult to ascertain because traditional sampling techniques are only available within the study area. The methodology presented in this paper can be used to determine the freight movements that occur simply because the study area is along the travel path between unrelated origins and destinations. Overall, this methodology is intended to serve as a starting point for statewide freight flow models interested in using the FAF2 database, but facing the difficulty in understanding the methods to obtain the data and extract the data that is appropriate.

3.3 Local Pass-through from a Statewide Model

After looking at the national model for determining the amount of pass-through trucks that would be present simply because Alabama on the shortest path between origin/destination, the next items was to disaggregate the FAF2 to the county level and include the amount of freight traffic that originated/terminated within Alabama. This involved the development of a statewide freight flow model and method to disaggregate the FAF2 data from the two counties provided in the FAF2 database to the 67 counties in Alabama. Then, the modeling environment needed to be adjusted to allow for the freight volumes to be assigned to all possible combinations. Finally, the modeling structure was modified to account for the pass-through that was generated within the state, terminated within the state, or both.

The model that was developed was created in CUBE/TRANPLAN and contains all interstate and US highways in Alabama. Additionally, some state highways were included to provide continuity of the roadway network and make counties accessible. The modeling network developed is shown in Figure 3.12.

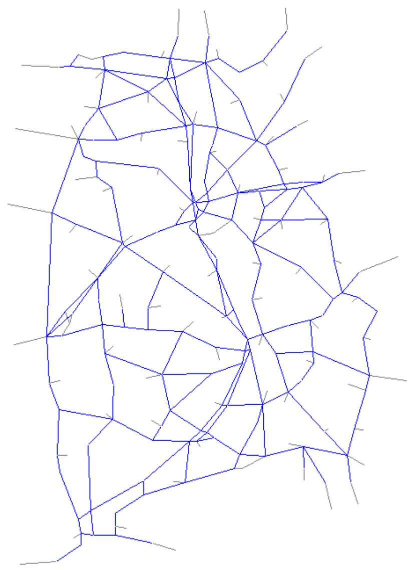


Figure 3.12. Statewide roadway network

The model used to disaggregate the FAF2 data to the counties used the personal income and value of shipment for the counties. This disaggregation is outlined in the FAF2 report submitted to ALDOT, therefore it not presented here. Additionally, the trip purposes used in the assignment are in the FAF2 report and are not presented here.
The modeling effort from the statewide freight model has been validated to 2002 counts obtained from ALDOT. The validation chart is shown in Figure 3.13.

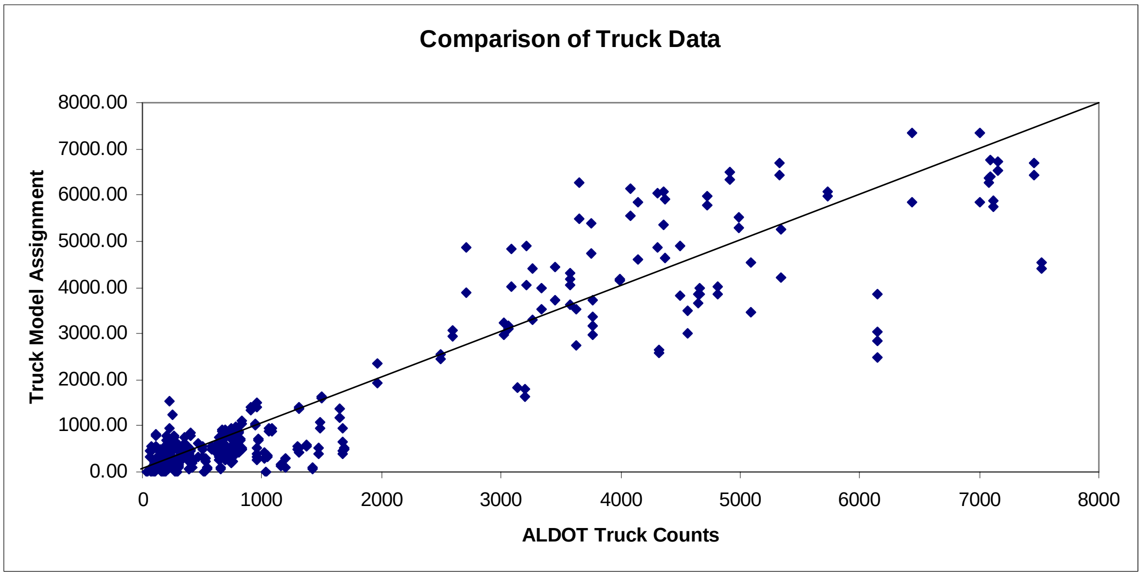


Figure 3.13 Validation of the Statewide Model

The statewide model was also assigned with the FAF2 2035 freight flow data. The same disaggregation procedure and trip purposes were used in the process. The output from the 2035 was used in the Statewide Travel Demand Model developed for ALDOT by Carter Burgess. The 2035 model output with roadway thickness proportional to daily truck volume is shown in the following figure.

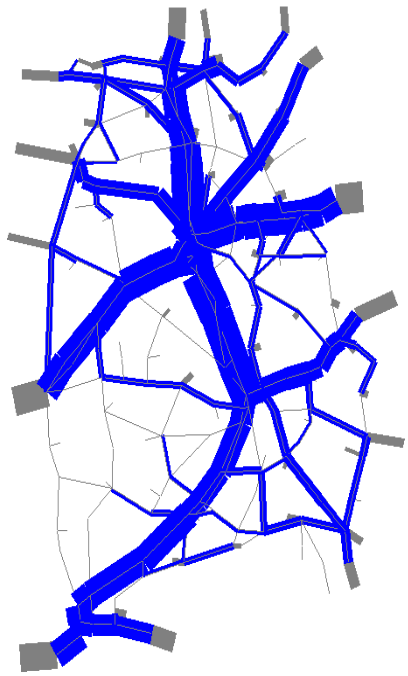


Figure 3.14 Statewide Model with FAF2 2035 daily truck volumes

3.3.1 Montgomery MPO Case Study

To demonstrate the applicability of using the FAF2 data for local pass-through modeling, a study was conducted to highlight the truck traffic passing through the Montgomery MPO. For the analysis, the statewide model was used and the CUBE/TRANPLAN control files used to operate the model were adjusted to assign all trips, with the exception of those that originated or terminated within the Montgomery MPO boundary. For the study, the counties that were excluded from the assignment were Montgomery, Autauga and Elmore. It is understood that the Montgomery MPO boundary does not include all of these three counties; however, the majority of activity in these three counties is included in these three counties.

The process of removing the trips from the trip table prior to assigning to the roadway network is performed through a MATRIX UPDATE module in CUBE/TRANPLAN. Additionally, a series of post-processing modules have been developed to identify specific volume of pass-through truck for the MPO. Examining the data for the

Montgomery MPO, the pass-through daily truck volumes are shown in the following table.

Table 3.5. Daily Truck Volumes Expected to Pass-through Montgomery MPO

	Daily Truck Volumes		
Origin Road	Interstate 65 South of Montgomery	Interstate 65 North of Montgomery	Interstate 85 North of Montgomery
Interstate 65 South of Montgomery	4,900 trucks entering study area	4,300 trucks	500 trucks
Interstate 65 North of Montgomery	4,580 trucks (140 to West US 80)	6,200 trucks entering study area	1,540 trucks (1,290 to South US 231)
Interstate 85 North of Montgomery	1,820 trucks (1,050 to West US 80)	300 trucks	2,140 trucks entering study area

As can be seen from the table, the daily truck volumes expected to pass-through the Montgomery MPO are significant, especially when considering these identified roadways serve as the main commuter roads for residents of the study area.

3.4 Summary

The development of the procedure to forecast pass-through freight within Alabama at the local level involved several steps. Initially, the Freight Analysis Framework, Version 2 Database required study to understand the complexity of the database. Then, the national pass-through freight volumes were researched to understand the implication of freight originating/terminating outside the state and the impact of this freight on roadways within Alabama. Using the statewide model, tools and procedures were developed to examine the impact of Alabama's freight to local areas.

It is important to note that the work presented focuses on Montgomery and the Montgomery MPO. However, this work is easily transferable to all other MPOs within the state and the models and tools developed are maintained at UAH to provide pass-through freight volumes for other MPOs.

4. Conclusions

Although this was a combined project, the research had two distinct focuses, the determination of final demand goods distribution and the development of local pass through freight traffic for modeling purposes.

The understanding of the final demand goods distribution is an undertaking that previously had not been attempted and the knowledge of industry supply chains will be beneficial in understanding freight needs to allow for this consideration in transportation planning and network investment.

Industry sectors may have multiple transportation network designs built or adapted by individual companies with efficiency measured in terms of total cost and elapsed-time. Approximately 7% of companies today are effectively managing their supply chain; however, these companies are 73% more profitable than other manufacturers (8). Companies that manage their freight transportation and logistics operations best do possess a competitive advantage over other companies. Transportation infrastructure in Alabama should be seen as an advantage in attracting these highly competitive companies to provide jobs and opportunities in the state.

Interesting knowledge was gained in understanding freight and the purpose and function of distribution centers in the 21st century supply chain. Freight destination was an unexpected characteristic in that the distribution centers are no longer only supplying retail stores but increasingly fill orders delivered directly to the customer. The furniture sector appears to be a leader in using this model outside of the parcel services companies.

The methods developed in data analysis, including the multi-step process of allocating shipments first to freight zones and then to counties produced reasonable results that can be repeated. Personal Income seems to have some merit as a predictor of final consumer demand.

The discovery and revelation of the pass through freight in a local area is vital to the transportation planner in performing required planning activities, especially since these pass through freight trips cannot be surveyed using traditional methods.

Further research into the appropriate factors to determine final demand, and the use of pass through data for planning and modeling activities at the MPO level is needed. The research performed in this project has provided researchers with indications that we are on the right track and that refinement of the methods and tools use here is warranted.

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