US Department
of Transportation

Federal Highway Administration

Commercial Vehicle Fleet Management and Information Systems

Technical Memorandum 1

Classification of Fleet Operations, and Selection of Candidate Case-Study Fleets

DTFH61 -93-C-00084

November 4, 1994

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Prepared for

Federal Highway Administration

November 4, 1994

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1.0 INTRODUCTION

1.1 STUDY BACKGROUND

The economic well-being and competitiveness of the U.S. economy depend heavily on reliable and efficient freight movements. Trucking accounts for about 75 percent ($270 billion) of the $350 billion spent annually on freight transportation. The application of Intelligent Transportation Systems (ITS)[1] technologies, such as automated vehicle tracking and communications systems, onboard computers, and routing and dispatching systems, can greatly enhance the effectiveness of truck fleet management. Some trucking, bus, and service fleets have readily adopted these technologies, but many others have been slow to take advantage of them.

To date, much of the work on ITS for commercial vehicle operations (ITS/CVO) applications has been pushed by technology; relatively little attention has been given to the fleet management needs of motor carriers, interstate bus fleets, and urban service fleets. This study will begin to address this issue and show how the development of ITS commercial vehicle applications might respond to the needs of these fleets and the customers they serve. Because the national economic benefits of better fleet management may be significant, and because potential solutions may cross governmental or jurisdictional boundaries, the study also will evaluate the potential for a Federal role in the development of systems to meet these needs.

1.2 SCOPE OF THIS TECHNICAL MEMORANDUM

The FHWA has commissioned this study to determine if there are fleet management needs that can be met through public sector involvement in the development of ITS systems. As part of this examination, this technical memorandum responds to Tasks A, B, and C. It examines how the need for ITS technology to improve fleet management varies with trucking and intercity bus fleet characteristics such as the client industry served, operating patterns, corporate structure, and reporting requirements. This memorandum describes some of the forces driving the industry's increasing interest in fleet management, presents several alternative ways of categorizing the trucking industry from a fleet management perspective, and recommends candidates for detailed fleet management needs case studies later in this project.

1/ Formerly known as Intelligent Vehicle Highway Systems (IVHS).

2.0 MARKET FORCES DRIVING FLEET MANAGEMENT PRACTICES

2.1 INCREASING EMPHASIS ON CUSTOMER SERVICE

The pressures and opportunities of the global marketplace are forcing many U.S. companies to change the way they do business. Many of the changes, such as the use of overseas parts suppliers, the introduction of just-in-time manufacturing and distribution systems, and an increased emphasis on quality and customer service, directly affect motor carrier operations, particularly for long-haul truckload carriers. For example, as manufacturing and distribution industries seek to reduce inventory carrying costs by implementing just-in-time production and retailing systems, they are asking carriers to provide more frequent and timely deliveries to resupply assembly lines and restock retail shelves. As more companies establish overseas production facilities, businesses are asking carriers to participate in global intermodal supply chains.

In addition, because of the high value of many shipments, businesses are asking carriers to provide greater control over shipments, tracking not only trucks but also individual packages. To meet these demands, carriers have developed the capability to track trucks and shipments, accurately predict pick-up and delivery times, and communicate the progress of shipments to customers.

The motor carrier industry has moved rapidly to accommodate these demands. This is affecting the industry in 2 ways that are relevant to ITS. First, the level of management and technological sophistication in the industry are increasing. The leading sectors of the industry have made the transition from "mom and pop" operations to national and international scale business operations, able to recruit and retain first-class technical, managerial, financial, and legal staff. This has given the industry a much greater capability to appreciate, develop, and apply new technologies. At the same time, it has given the industry a much stronger and more knowledgeable voice in public policy debates about transportation. As the industry approaches ITS, it will be more active and more sophisticated in voicing its needs and concerns, and it will be under more pressure from its shippers and receivers to demonstrate the cost-effectiveness of their operations.

A second effect of changing customer service demands has been to catalyze the evolution of trucking companies into transportation companies. Companies as diverse as J.B. Hunt, a national truckload carrier, and United Parcel Service, once exclusively a small parcel less-than-truckload carrier, now provide multimodal transportation services (i.e., including truck, rail, air, and steamship). In some cases, these companies also provide complete logistics services, including transportation, warehousing, scheduling, final assembly, tagging, packaging, and billing for their clients. These companies (and their clients) will not evaluate only the impact of ITS on motor carrier operations; they also will evaluate the impact of ITS on their total logistics supply chain and distribution network. ITS may provide significant cost-efficiencies to local truck movements, but if that truck movement is not a time- or cost-sensitive link in the company's national or global logistics network, the adoption of ITS technologies may not be

supported. This means that metropolitan areas and states must be willing to look well beyond their borders in determining the costs and benefits of ITS for the trucking industry.

2.2 COMPETITIVE PRESSURES

The second major force shaping the motor carrier industry's fleet management practices is competition within the trucking industry. Until the 1930s, truck movements were local. Concerns about road construction costs and taxation to pay for repairs were local and state issues, and regulations governing motor carriers were tailored to the need of the local economy and geography. By World War II, the situation had changed dramatically. Better truck engines, more sophisticated paving techniques, and public investment in roadways gave trucks greater range and capacity, permitting businesses and industry to locate away from railroads and ports. As businesses expanded their markets, truck operations expanded along with them. Interstate motor carrier operations became more commonplace, providing relatively uniform freight services across the United States, but motor carrier regulations remained "balkanized" as motor carriers were subject to regulation by every state through which they passed. Because each state had regulations and administrative agencies uniquely fitted to its own needs, the regulatory system was staggeringly complex and costly for interstate motor carriers.

The problems with interstate motor carrier regulation were widely acknowledged by the motor carrier industry, state government, and the Federal government by the 1960s. Numerous efforts were made to standardize equipment, permitting, and tax reporting for trucks in interstate operation. Most of these efforts had limited effect, due to organizational inertia and other common institutional problems. The states were concerned about protecting their own business traditions and their revenues. The motor carrier industry was fragmented and sought to protect local motor carriers from out-of-state interests. While the Federal government watched all this with frustration, it was unwilling to push into areas where states rights were paramount and the Federal capacity to intervene was limited.

The situation had become acute by the 1970s, especially for business and industry, which were serving growing national and international markets and looking for ways to improve productivity and reduce costs. The response was the economic deregulation of the motor carrier industry in 1980 and the imposition of uniform Federal size and weight standards for trucks operating on the Interstate System. These actions triggered a massive restructuring of the motor carrier industry and sharp competitive pressures to reduce costs. Freight rates dropped, business entry and failure rates shot up sharply, and cost savings were found in motor carrier management, engine and vehicle technology, and labor.

In the decade since the deregulation of interstate motor carriers, the motor carrier industry has evolved from a highly regulated industry to an extremely competitive one. While the motor carrier industry as a whole has grown at about the same rate as the gross national product, profit margins in today's industry are relatively small, and profits are generally low compared to the profit margins realized prior to deregulation. The regulated for-hire segment of the industry has undergone the most change, but deregulation has also forced parallel changes in the management of private fleets.

The industry is about to undergo a second wave of deregulation, focusing on intrastate motor carrier operations. In Congressional legislation passed in August 1994 and due to take effect in January 1995, states will be preempted and prohibited from regulating business entry, pricing, and service provision by intrastate motor carriers. The practical effect of the legislation will be to "level the playing field" among motor carriers operating in commercial port districts, operating intrastate, and operating interstate. Although some deregulation of intrastate motor carrier operations had been anticipated for years, this complete preemption and deregulation of intrastate trucking was a shock to most states and many motor carriers. The action is expected to trigger another round of restructuring, consolidation, and cost cutting across the industry.

The forces of competition are pushing the industry to find ways to reduce empty miles and operating costs through better vehicle and driver management. In part, this is being accomplished through the application of vehicle location and communication technologies, but most of the early productivity gain has come through the use of computer-aided dispatching systems and the introduction of onboard computers that enable motor carriers to track and analyze the performance of their vehicles and drivers. Private fleets and for-hire less-than-truckload pick-up and delivery operations have led the industry in the adoption of these technologies.

2.3 INCREASING CONGESTION

The third major force affecting fleet management practices is congestion. In 1981, the FHWA estimated that 16 percent of urban interstate miles were severely congested; by 1988, over 30 percent of urban interstate miles were classified as severely congested. This congestion has a significant impact on trucking because one-third of all truck-miles of travel occurs in large urban areas, with an estimated two-thirds of that mileage on freeways.

As congestion has increased, trucks and cars increasingly are competing for the use of limited available capacity. Competition for highway space among all highway users is likely to intensify as travel demand increases and the provisions of the Clean Air Act force metropolitan areas that do not meet air quality standards to reduce vehicle miles of travel and vehicle emissions. Some public sector responses to congestion, such as the Los Angeles proposal to ban all large trucks from the freeways during peak commuter periods, could have serious economic consequences.

Major relief cannot be anticipated from expansion of the highway system. New highways will be built, but the pace of construction will be slow compared with that of the last 40 years. The new Federal Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) explicitly recognizes this. It shifts the focus of highway programs to better management and more efficient use of existing transportation systems, rather than expansion of highway capacity.

One type of industry response to congestion is to shift operations out of the peak commute periods or to alternative routes whenever possible. A Cambridge Systematics study of the fleet management practices of several hundred truck fleets in Los Angeles, San Francisco, and San Diego found that some carriers were able to shift their operations to the midday or evening periods to minimize congestion delays. For-hire and private truckload carriers serving plants

and warehouses had the most flexibility in rescheduling trips; less-than-truckload carriers and private distribution fleets serving office and retail customers had the least flexibility to change schedules.

Another industry response to congestion has been to introduce congestion information into routing and scheduling decisions. Recently, the ATA Foundation sponsored a demonstration with TRANSCOM, a traffic information clearinghouse set up by 15 public agencies in the New York-New Jersey metropolitan area to provide current information about construction delays and highway incidents. The ATA and TRANSCOM cooperated to provide a test group of motor carriers with pagers and facsimile machines so that up-to-the-minute traffic information was available to dispatchers. Test participants reported that the traffic information saved time for their drivers, provided that alternative routes were available. Driver acceptance was high, but dispatchers generally were less enthusiastic. The dispatchers appreciated the information, but they were unable to organize and process the large volumes of traffic information in a timely fashion.

The TRANSCOM demonstration and related studies of highway incident management programs point up 3 problems that must be addressed before fleets can make effective use of congestion information in fleet management:

- Current traffic monitoring and reporting systems do not provide enough timely information to influence routine routing and dispatching decisions. Even if timely, accurate information were available, the current generation of routing and scheduling software cannot readily incorporate it.

- Trucks have special routing constraints that are not yet being systematically addressed in the development of urban ITS programs. The focus of urban ITS programs – Advanced Traffic Management Systems and Advanced Traveler Information Systems – is the private automobile driver, who accounts for 95 percent of the traffic on most urban highways. Information that suffices for commuters is often inadequate for trucks. For example, alternate routes and diversion routes around incidents must be safe for trucks (i.e., have adequate overhead clearance, bridge capacity, and turning radii) and must comply with local access, noise, and hazardous materials movement regulations.

- Trucks need information about congestion conditions on a broader geographic scale than a single urban commuting area, which is the range of most urban ITS programs. Most trucks operate within a 80.5- to 322 km (50- to 200-mile) radius of their terminal, a distance that often falls outside or between the coverage of individual urban ITS programs.

2.4 REGULATORY COMPLIANCE

The fourth major force that is strongly influencing fleet management practice is the burden of compliance with motor carrier regulatory requirements. Although many businesses and trucking companies operate in multiple states, motor carriers remain subject to regulation and taxation by each individual state through which they pass. Because each state has its own unique needs, administrative structure, and regulations, the motor carrier regulatory system

has become staggeringly complex. This complexity imposes a considerable burden on both the motor carriers, who must comply with the regulations, and the state agencies, who must administer them.

The focus of current state and Federal ITS/CVO programs, such as the HELP/Crescent Demonstration and Advantage I-75, is to increase the efficiency and reduce the cost of regulatory transactions (and vehicle movements) by using technology. The technological building blocks for automated clearance at weigh stations and ports-of-entry are automated vehicle identification, weigh-in-motion, and automated vehicle classification systems. Under a fully realized ITS/CVO program, carriers could obtain all credentials and permits in one electronic transaction with a single state ("one-stop shopping") and be able to cross state borders without stopping repeatedly for the purchase or verification of credentials, size and weight compliance, and safety status ("transparent borders").

2.5 INFORMATION TECHNOLOGY

A revolution is occurring in today's transportation industry, brought about by the introduction of information and communications technologies. These technologies have enabled business and industry to organize and control regional, national, and international networks of suppliers and distributors for their products and services. The application of the same technologies to trucking has enabled motor carriers to closely monitor and manage the operation of their fleets regionally and nationally.

Today's more sophisticated trucking fleets are equipping their vehicles with onboard computers and communication systems that keep the drivers in constant contact with their dispatchers and clients. These systems make it possible for carriers to provide clients with information to assure the safety and security of their cargo. For example, a truckload carrier hauling food for a national fast food chain will monitor the temperature of a refrigerated trailer. The trailer may be compartmentalized so that different food stuffs, such as vegetables, meats, and bakery products, can be refrigerated at different temperatures. Each compartment will be monitored electronically, and a continuous temperature record will be kept in the onboard computer as part of the carriers quality assurance program. The truck's location also may be monitored by a global positioning system (GPS) that calculates the truck's position by the triangulation of timed satellite signals.

At periodic intervals, the status of the refrigeration equipment as well as the truck's location, speed, and rate of fuel consumption will be transmitted by satellite communication link to the motor carrier's dispatch office, which in turn will relay information on the status of the load and its expected time of arrival to the shipper and receiver. Leading-edge carriers routinely provide large clients with direct dial-in access to their computers and provide automated menus and voice synthesizer reporting for smaller clients who call in to track the progress of their shipments.

Some carriers are complementing this equipment with automated vehicle control systems that monitor truck speed and vehicle spacing, warning the driver and, in emergencies, automatically applying the brakes when the truck follows another vehicle too closely. The cost of these

systems, which maintain a record of the vehicle's movements, often are underwritten by the carrier's insurance company.

Electronic transponders constitute another layer of technology on trucks. Mounted behind the windshield or on the bumper of the tractor, on the trailer, or on the container and its chassis, electronic transponders can be interrogated by roadside readers while the truck is traveling at highway speeds. Transponders are in operation today to collect tolls without stopping trucks; to identify trucks and permit legally compliant trucks to bypass state weigh stations and ports-of-entry; to verify credit at fuel stations; and to track the location of tractors, trailers, containers, and chassis in large intermodal terminals and truck yards.

The next generation of information and communications technologies being deployed to trucks will move many of the business functions from the office into the cab of the truck. Order taking, route planning, waybill processing, and other functions, which are done today in the motor carrier's office, are being transferred to the truck. Today's Federal Express truck is a sophisticated mobile office, but even less time-sensitive operations routinely carry onboard fax machines to communicate with dispatchers and clients.

The number of trucks and fleets currently equipped with such systems is limited; however, customer service expectations and competitive pressures will force the rapid adoption of these technologies among many segments of the motor carrier industry over the next decade. For ITS programs, this means that trucks will be among the most electronically sophisticated vehicles on the road. Many will be pre-wired for this equipment by truck manufacturers and ready to accept ITS equipment.

2.6 LABOR PRESSURES

Changing demographics and increasing government regulation of the workplace will require trucking companies to dedicate more resources to recruiting, training, and managing drivers. The average age of the U.S. workforce is increasing, and the motor carrier industry is having a difficult time recruiting younger drivers at current wage rates. Annual driver turnover rates of 100 to 400 percent per year are not uncommon in some segments of the for-hire industry. It is likely that the trucking industry will have to turn to new sources for qualified drivers, including women, minorities, and military veterans.

As the cost of recruiting and retaining drivers rises, the pressure on motor carrier managers to make cost-effective use of their time also will increase. To the extent that ITS systems make it easier and more cost effective to operate trucks, ITS will be attractive to the industry because it will help to offset the increased labor costs; however, if the cost of using ITS is high, because of user charges or special equipment that must be installed on a truck, then ITS will be resisted.

2.7 INTERMODAL FREIGHT OPERATIONS

A significant change in the last decade has been the accelerating integration of truck and rail service to provide intermodal freight service. Freight movements by intermodal containers have been growing rapidly. The number of intermodal containers coming into and out of the

United States has been growing at an average annual rate of just over 7 percent. Domestic containers, which are a new, small, and rapidly growing market, are expected to increase at an average annual rate of about 25 percent over the next decade. Roadrailers (truck trailers equipped with detachable railroad wheels and retractable highway wheels) and other new half-railcar/half-truck-trailer vehicles are expected to grow at about 10 percent per year, cutting into the volumes of piggyback trailers (conventional truck trailers carried on railroad flatcars), which are projected to decline about 10 percent annually.

The major force driving the expansion of intermodal freight services has been pressure to cut total transportation costs. The introduction of intermodal stack trains, especially double-stack trains, has cut the cost of moving a container long distance [over 1,932 km (1,200 miles)] approximately in half, making intermodal service competitive with long-haul truck service. Improvements in equipment, competition among railroads, and economies of scale in handling containers at terminals are expected to drive the cost of container moves down further, eventually making intermodal services in high volume corridors competitive with truck services at distances of 805 to 966 km (500 to 600 miles).

2.8 TRUCK SIZE AND WEIGHT

Labor costs account for upwards of 60 percent of truck operating costs. To make a truck trip more productive, a motor carrier must generate more revenue per mile. The most direct way to do this is to increase truck capacity, and therefore, the amount of revenue freight that can carried per trip. This calculus has created steady pressure from motor carriers and shippers to increase the size and weight limits for trucks. A major step in this direction was achieved in the Surface Transportation Act Amendments of 1982 (STAA) when Congress established an interstate standard truck by setting maximum size and weight limits for trucks operating on the designated national truck network (effectively, the interstate highway system) and preempted states from setting lower limits on these roads.

Subsequent efforts by the motor carrier industry to increase truck size and weight limits to accommodate larger and longer combination trucks (i.e., tandems, turnpike doubles, and triples) have been resisted by the states and the railroads, the former anxious about pavement wear and the cost of bringing substandard bridges up to new weight standards, and the latter anxious about the potential of freight and revenue diversion from steel-wheeled railroads to rubber-tired railroads. The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) declared a moratorium on the expansion of longer combination vehicle routes, forcing the FHWA, the states, and the motor carrier industry to restudy the economic and safety implications of larger and heavier vehicles. Although this effort is underway, it is unlikely that the issue will be resolved by the time of the next highway reauthorization bill in 1997.

The longer-term outlook is for some increase in the size and weight of trucks. It is likely that longer combination vehicles will be allowed to operate over more routes than they do today, but under permitting programs that regulate driver and vehicle safety and tax the vehicles in proportion to the additional wear that they are expected to place on the highways. It is also likely that tractor semi-trailers eventually will be allowed to operate at higher gross weights if

additional axles are added to spread the weight and reduce the weight on each individual axle. The Canadian motor carrier industry operates single- and multi-trailer trucks (researched and developed in partnership with the Canadian government) that have lower individual axle weights, higher gross weights, and better stability than comparable American trucks. The demonstrated effectiveness of these designs is pressuring the FHWA to consider similar designs. This trend suggests that ITS programs must anticipate greater diversity in truck size and weigh across the U.S. fleet than exists today.

2.9 SAFETY

Truck-involved fatal accident rates have declined over the last 2 decades despite a steady increase in truck-miles of travel over the period. Nevertheless, trucks are involved in a disproportionately high number of fatal accidents. Moreover, truck accidents, especially major accidents that can block urban freeways for hours at a time, impose a huge economic cost because of the congestion and delay that they cause to the other truck and automobile drivers caught up in the queue behind (and across from) an accident. The Occupational Health and Safety Administration (OSHA) classifies trucking as a high hazard industry. The consequences of this classification are higher insurance and driver compensation rates, which undermine the profitability of the industry.

Two broad initiatives are underway to address these problems. The first is a slowly emerging consensus that safety enforcement must focus more closely on the driver. Although there are questions about the reliability of accident reports, the general pattern of research findings suggest that driver error, not mechanical failure, is the primary cause of truck-at-fault accidents. Nonetheless, current enforcement programs focus primarily on the mechanical condition of the truck and only secondarily on the condition of the driver. Shifting the focus of enforcement efforts to the driver is difficult because driver inspections require that the truck be stopped and the driver interviewed out of the cab – time-consuming and difficult process on congested urban freeways and high volume interstates.

The second, and closely related, initiative is to use technology to monitor the condition of drivers and trucks. The FHWA and motor carrier manufacturers are experimenting with driver fatigue monitoring and onboard equipment monitoring and diagnostic systems, with much of the early attention going to brake failure and roll-over warning systems. This technology is in development, but is several generations away from commercial deployment in motor carrier fleets.

Truck safety is a significant and politically visible problem. ITS technology that can demonstrate significant safety benefits, either by improving driver performance, stabilizing vehicle handling, or reducing the risk that other vehicles will collide with trucks, would be perceived by the motor carrier industry and government as a desirable investment.

3.0 THE NEEDS OF THE MOTOR CARRIER INDUSTRY

3.1 INDUSTRY EXPERIENCE WITH NEW TECHNOLOGY

3.1.1 Nature of Cooperation with Public Research

Until recently, public sector investment in research related to motor carriers and motor carrier operations has been modest. Most public sector research conducted at the state and university level has been directed toward structural and materials engineering problems involved in designing roads, bridges, and pavements. The portion of this research that has focused directly on trucks typically has involved the collection of empirical data on of tire pressures, axle loadings and spacing, and gross truck weights factors that are needed to determine how loaded trucks consume pavement and stress bridges. Because these data can be collected by weighing trucks during regular weight and safety inspections, the need for formal involvement of motor carriers in the research has been limited.

The public sector has worked directly with engine and truck manufacturers on energy consumption and engine emission issues. For the most part, this work has focused on the ability of truck designs and engine technology to meet regulatory standards in those areas. This research has involved close cooperation between truck manufacturers and motor carrier operators, and between truck manufacturers and the public sector, but seldom directly between the motor carriers and the public sector.

The major link between highway research and vehicle research has been safety research. The public sector invests heavily in this area, but automobiles, rather than trucks, have been at the center of this research. Since much of this work is done by statistical analysis of accident records, motor carrier involvement in truck-involved accident research has been indirect, generally limited to providing data and reviewing findings.

At the metropolitan level, public research on trucks has focused almost exclusively on the establishment of building and zoning standards to accommodate truck docks and loading zones. Traffic engineering research on truck movements has been limited to specific projects. The major exceptions to this have been research during the 1960s and 1970s on truck movements in the garment district of New York City; and research on metropolitan truck movement patterns in Chicago by the Chicago Area Transportation Study, the region's metropolitan planning organization.

The public sector's most controversial attempt to apply new technology research to the motor carrier industry-involved anti-lock braking systems (ABS). After ABS emerged as a viable technology in the 1970s, Federal regulations were put in place requiring the introduction of ABS to trucks. The trucking industry resisted the technology vociferously, concerned as much about the additional cost of the systems as their technical performance. In application, ABS technology proved to be more difficult to maintain and less reliable than expected, and eventually the regulations were rescinded. ABS technology has evolved rapidly over the last 2 decades and, although it is not mandated, it is now gaming acceptance among motor carrier operators as

a desirable safety system. Nevertheless, the experience left the motor carrier industry with an abiding skepticism about the public sector's ability to develop and introduce new technology to the trucking industry.

Over the last decade, the relationship between public sector research and the motor carrier industry has shifted from an arms-length relationship to something approaching a handshake. Much of the impetus for this change has come from the motor carrier industry, which has built a modest in-house and contract research capability through the American Trucking Associations' Trucking Research Institute (ATA/TRI) and more recently through the National Private Truck Council's Private Fleet Management Institute (NPTC/PFMI). From an early base of studies on tax and regulatory policy, the industry has expanded into safety and technology issues. Today, the ATA and NPTC are doing joint contract research with the U.S. Department of Transportation on topics ranging from driver fatigue to statistical reporting on the motor carrier industry.

Closer research relationships also have been developed between the states and the motor carrier industry. The catalyst for this has been Federal and state investment in ITS research state motor carrier regulatory administration and enforcement through the application of information and communications technologies. The research and project development work done under the ITS programs has provided a forum for the public sector and the motor carriers to the potential of technology to improve productivity and profitability on both sides.

To date, ITS research has focused on issues pertaining to state regulation of the motor carrier industry and interstate travel by motor carriers. Issues related to metropolitan truck travel, including congestion and road pricing, are still largely ignored in urban ITS research, which has its eye on the larger metropolitan automobile market. Consequently, as ITS programs evolve, they are likely to find a stronger base of public sector and motor carrier research on interstate transportation issues than on metropolitan transportation issues.

3.1.2 **The Industry Expectations of the Public Sector**

Recent Federal and motor carrier joint research notwithstanding, the trucking industry's expectations of the public sector are shaped primarily by the long-standing adversarial relationship between government and the motor carrier industry. Most state agencies view their primary roles with respect to the motor carrier industry as that of regulators and tax collectors. The states derive considerable revenues from motor carrier vehicle registrations and motor fuel taxes, and most are diligent about collecting those taxes. The motor carrier industry, whose heavy trucks account for most of the wear-and-tear inflicted on roads and bridges, are perennially anxious about state and Federal taxes, arguing loudly and long that the motor carrier industry is over-taxed and over-regulated as compared to other industries.

As a consequence of this tug-of-war, both the highway engineer and the motor carrier manager, have deeply ingrained suspicions of each other's motives. This distrust has been apparent in the debate over the value of ITS technology to the motor carrier industry. The earliest ITS program, the West Coast HELP (Heavy Vehicle Electronic License Plate) Program and its Crescent Corridor Demonstration along Interstate 5, was marked by constant feuding between

carriers and states over the ultimate purpose of the program. The state highway engineers maintained that the purpose of the program was to improve the productivity of the motor carrier industry, while the motor carriers maintained that the program was a technological Trojan horse designed to improve tax collection and, ultimately, to facilitate a national weight distance tax. Similar concerns are likely to arise from ITS programs, which raise many of the same issues of taxation, the business confidentiality of truck movement data, and the distribution of benefits.

4.0 MOTOR CARRIER INDUSTRY TYPOLOGY

4.1 TYPOLOGY OVERVIEW

Traditional industry typologies based on regulatory status and revenues are not adequate for evaluating the potential applicability of ITS to the motor carrier industry because they do not incorporate an understanding of the industry's key operational characteristics. In this section, an alternative typology of the trucking industry is developed, based on the following operating characteristics:

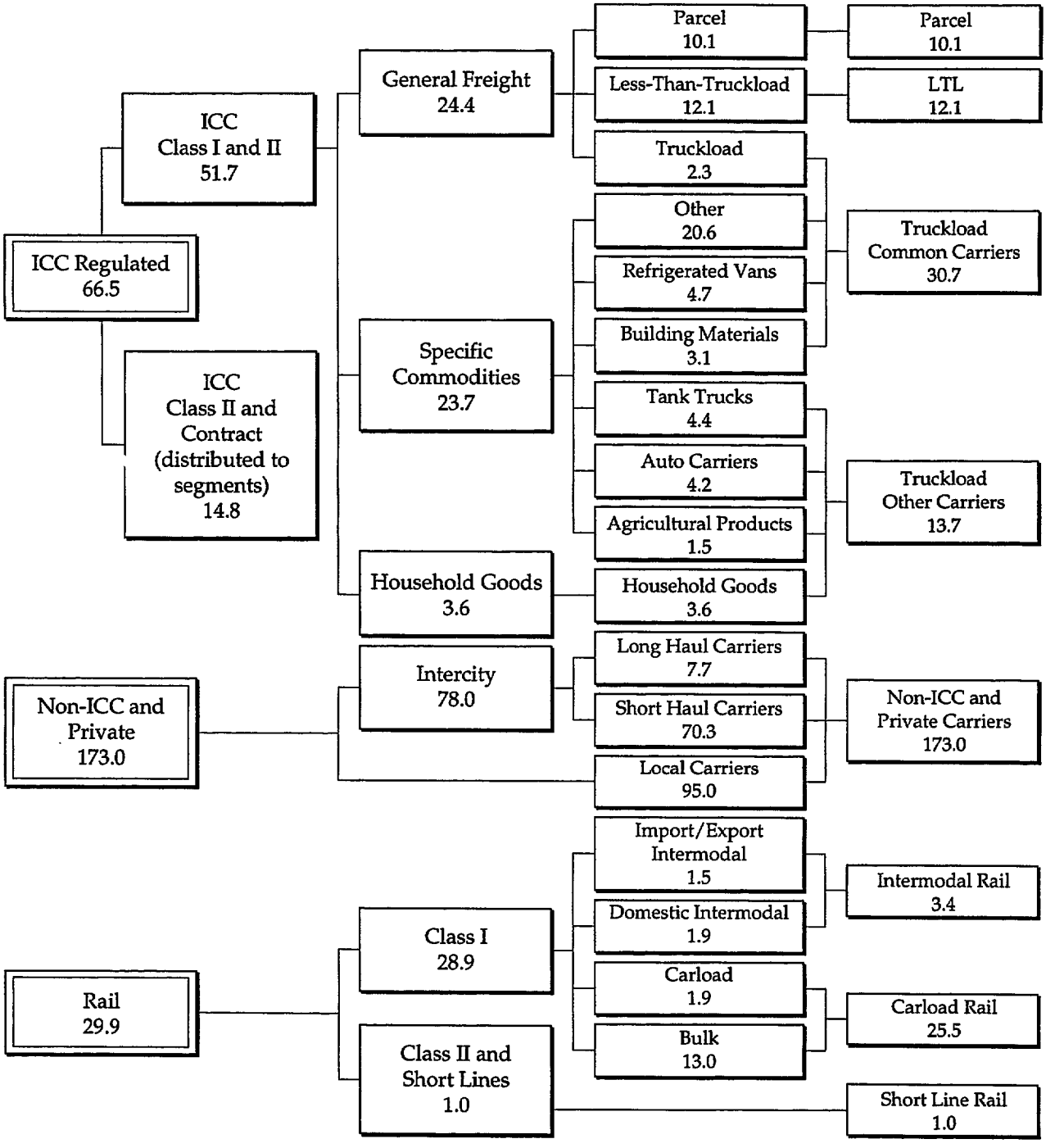
- Principal Product Carried, which differentiates among trucks carrying various types of products and accounts for the differing needs of the industries they serve;
- Geographic Range of Operation, which differentiates among local, regional, and national operating scopes;
- Fleet Size, which differentiates among motor carriers' needs and capacities for employing fleet management technology;
- Routing Variability, which differentiates motor carriers that operate repetitive, fixed routes (and therefore may have little need for truck routing and tracking systems) from variable route carriers, who may change their destinations daily (and therefore may benefit from the sophisticated tracking and routing capabilities provided by ITS); and
- Time Sensitivity of Deliveries, which differentiates those segments of the industry that operate with tight delivery schedules and therefore may find travel time savings provided by an ITS particularly useful.

4.2 NEED FOR A NEW TYPOLOGY

Many people view the trucking industry as monolithic, assuming that all trucks are 18-wheelers operating cross-country as part of large fleets. If this were true, it would be relatively easy to ascertain the industry's needs for fleet management technologies and systems. However, in reality, the industry includes many types of operations, equipment, and fleet sizes. The trucking industry is highly fragmented, reflecting the complexity and diversity of the many businesses, industries, government agencies, and consumers it serves. To identify the types of fleets that might benefit from the application of fleet management technology, it is necessary to develop a trucking industry typology based on the characteristics most relevant to determining fleet management needs.

The most common approach to industry segmentation has been to divide the industry by regulatory status and type of operation, as shown in Figure 1:

- For-hire truckload (TL) carriers: These carriers haul general freight and special commodities in truckload quantities, usually in a single move directly from the shipper to the receiver.



Source: Transmode Consultants, Inc. (based on ICC and industry data)

Figure 1. Traditional Market Segmentation (1988, Billions of Dollars)

Most for-hire truckload carriers are either regional or long-haul carriers (i.e., trans-continental) which operate on irregular schedules determined by the demands of shippers and receivers.

- For-hire less-than-truckload (LTL) carriers: These carriers haul general freight in less-than-truckload quantities, usually combining freight from many shippers to achieve cost-effective operations. Less-than-truckload carriers have 2 types of operations: a local pick-up and delivery operation running urban trucks on regular routes from a central terminal; and a line-haul operation running over-the-road trucks in relays from terminal to terminal across the country.

- Private truckload (TL) fleets: Like their for-hire counterparts, these carriers haul special commodities in truckload quantities, usually between manufacturing plants or from manufacturing plants to warehouses. These fleets make shorter moves and more scheduled moves than for-hire carriers.

- Private distribution (LTL) fleets: Private distribution fleets haul general freight and special commodities, typically with short-haul scheduled moves between warehouses and retail outlets. Also included in this category are local non-ICC-regulated for-hire carriers and local rental/moving fleets.

- Service fleets: These include utility company fleets, Federal government vehicles, state and local highway department trucks, fire apparatus, etc. Generally, these fleets operate dedicated equipment from a local garage with irregular routes and schedules.

This typology – based on the regulatory status of the carrier – has been widely used in the past to describe the trucking industry because these categories implicitly defined industry characteristics in a regulated environment (i.e., the Interstate Commerce Commission required for-hire fleets to report fleet size, revenues, etc. according to these regulatory categories). However, the deregulation of the industry in 1980 led to the elimination of many statistical and financial reporting requirements; consequently, there has been a decline in the amount of information available (particularly with respect to the for-hire segments).

At the same time, deregulation has led to considerable restructuring of the trucking industry: for-hire LTL carriers have acquired TL operations; private fleets have applied for ICC licenses to provide for-hire TL back-haul services; and firms that were once exclusively truck lines have diversified into air freight and intermodal services. Therefore, segmentation of the trucking industry by regulatory status may not be meaningful with respect to future fleet operations. In addition, this segmentation falls short because it ignores the type of operational characteristics that are most likely to affect the industry's adoption of fleet management technologies. An alternative industry typology is necessary to ascertain the fleet management needs of various parts of the trucking industry, including (but not limited to) truckload carriers, less-than-truckload carriers, private fleets, owner-operators, leasing operations, intercity buses, school buses, and urban pick-up and delivery fleets.

4.3 COMPONENTS OF THE NEW TYPOLOGY

4.3.1 Industry/Commodity

For the purposes of this ITS fleet management study, a new typology was developed, based on the assumption that there are 5 basic determinants of a carrier's fleet management needs:

- **Principal Product Carried.** Truck fleet operations are influenced, first and foremost, by the commodities they haul most often. Trucks carrying frozen vegetables, for example, will have different delivery schedules and production-to-distribution routes than will trucks hauling gravel or gasoline, both because of the nature of the products themselves, and because of the characteristics of the industries that produce and consume the products. Thus, different ITS technologies may be appropriate for different truck fleets, depending on the kinds of products they most often carry.

- **Geographic Range of Operation.** Fleet operations may vary depending on their geographic scale. Trucks operating locally within metropolitan areas [i.e., within 80.5 km (50 miles) of their base of operation] may face very different scheduling and routing conditions, and may operate on different classes of roadways, than trucks operating primarily at a regional scale [i.e., 80.5 to 322.0 km (50 to 200 miles) from base of operation] or national scale [i.e., over 322.0 km (200 miles) from base of operation]. These differences may influence the choices made by fleet managers and truck owners regarding investment in ITS systems.

- **Fleet Size.** The most obvious way in which fleet size may affect the adoption of ITS for fleet management is that companies with large fleets may have proportionately more resources available for maintaining and upgrading their fleets than will companies that operate only a few trucks. Even if budgets are proportional across fleet sizes, the absolute per-truck cost of installing certain ITS technologies may simply be out of range for small companies. Conversely, the total initial cost of implementing some ITS technologies may prove to be a significant burden for large fleets.

- **Routing Variability.** Generally, the greater the variability of a fleet's routes, the greater the incentive to use technology to track truck movements. Operators whose routes are subject to frequent or sudden changes may benefit from up-to-the-minute information concerning road closures, congestion and other factors. In addition, these operators also may benefit from the ability to track the locations of individual vehicles; such information would allow them to re-route vehicles rapidly, to choose the shortest or fastest alternate routes, and to minimize unladen mileage.

- **Time Sensitivity of Deliveries.** Time sensitivity refers to more than just the urgency of a shipment; it refers to the amount of time that is available in which to make a delivery (the delivery "window"), and also to the consequences for truck operators and the industries in which they work of missing specified delivery times. Time sensitivity is determined primarily by the product being carried and the industry being served. Trucking companies that operate on highly time-sensitive schedules can benefit greatly from the ability to track

individual vehicles and forecast delivery times precisely. For these companies, the added cost of implementing ITS fleet management systems might be justified.

4.4 TYPOLOGY STRUCTURE

The typology developed for this study can be described in several ways. For example, the factors may be set up as a branching tree, with an individual fleet being represented by a path through a set of branches; such trees are shown in Figures 2a and 2b. Individual segments of the trucking industry can be described by single paths through the branches, such as a retail industry / national scope / fixed-route / non-time-sensitive delivery.

The information in the typology also may be used to construct worksheets that provide individual fleet profiles. Examples of fuel worksheets are presented in Figure 3a and 3b. The worksheet essentially is a shorthand form of the tree; selections on the worksheet correspond to a single path through the tree. Therefore, a single worksheet describes a particular industry segment with unique characteristics and operating requirements with respect to fleet management.

In Sections 5.0 and 6.0, the typology trees and worksheets are used to evaluate various trucking industry segments as candidates for more detailed case studies of fleet management needs.

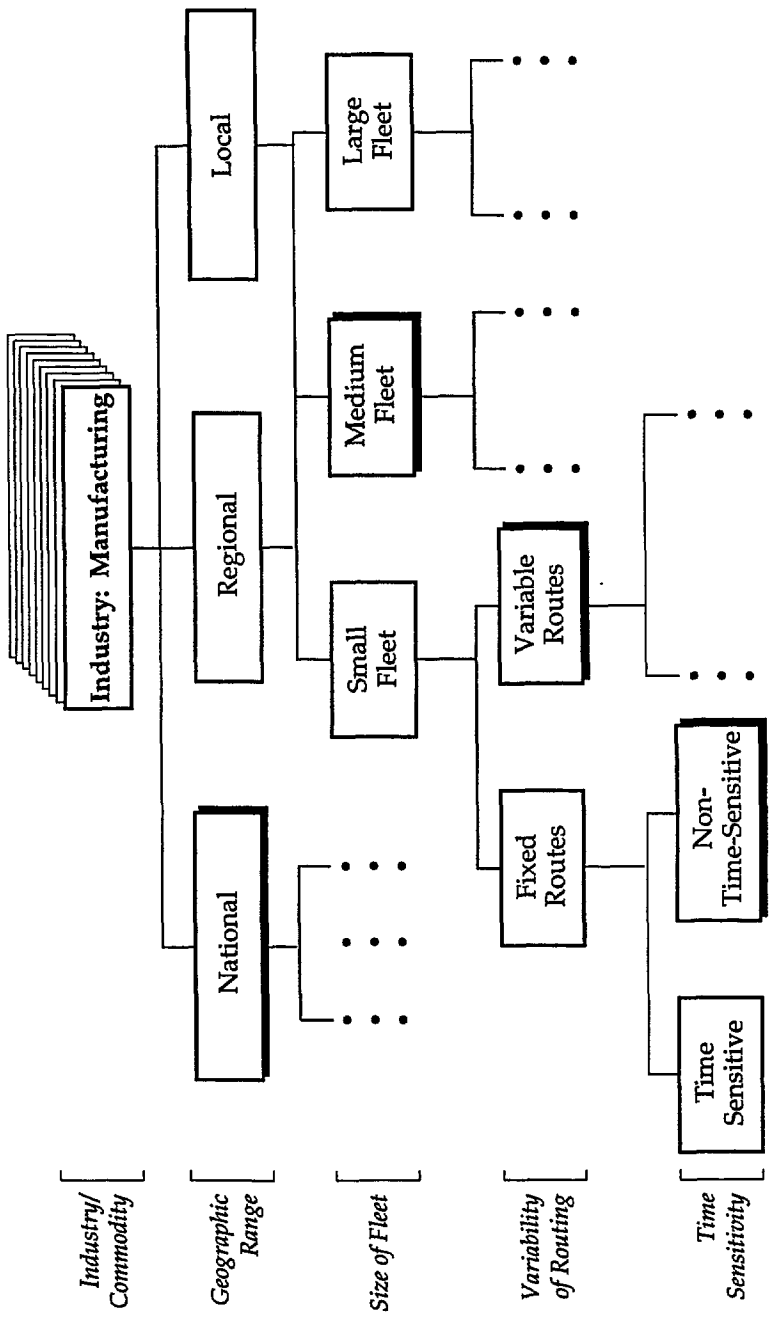


Figure 2A. Fleet Management Typology for Trucks

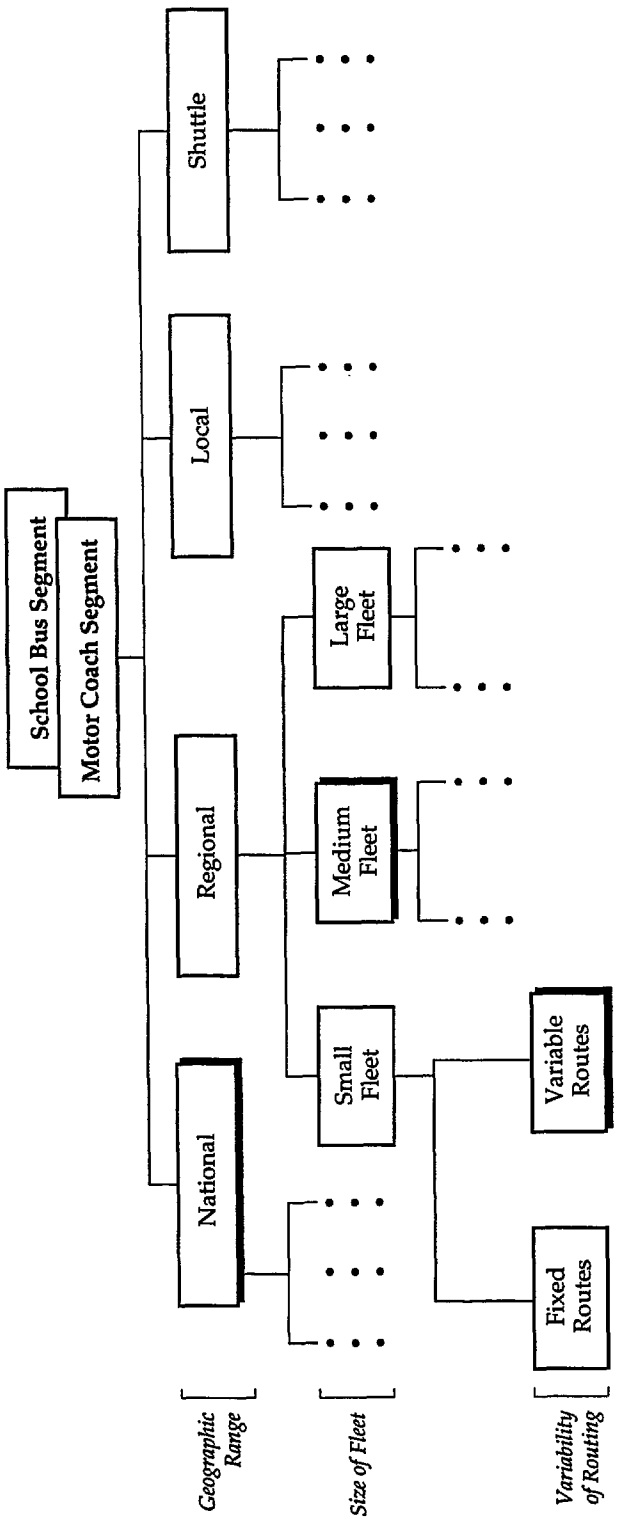


Figure 2B. Fleet Management Typology for Buses

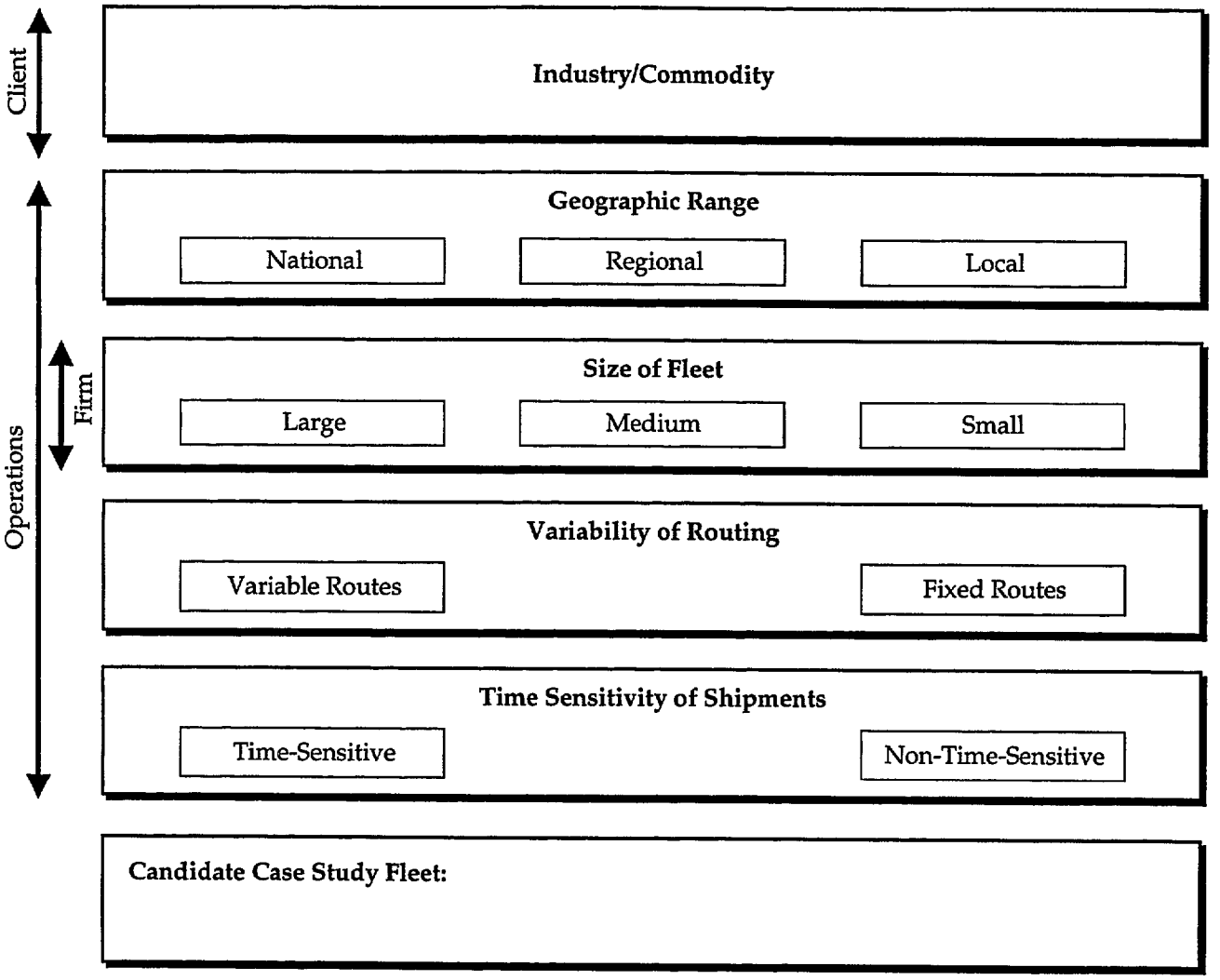


Figure 3A. Typology Profile Worksheet for Trucks

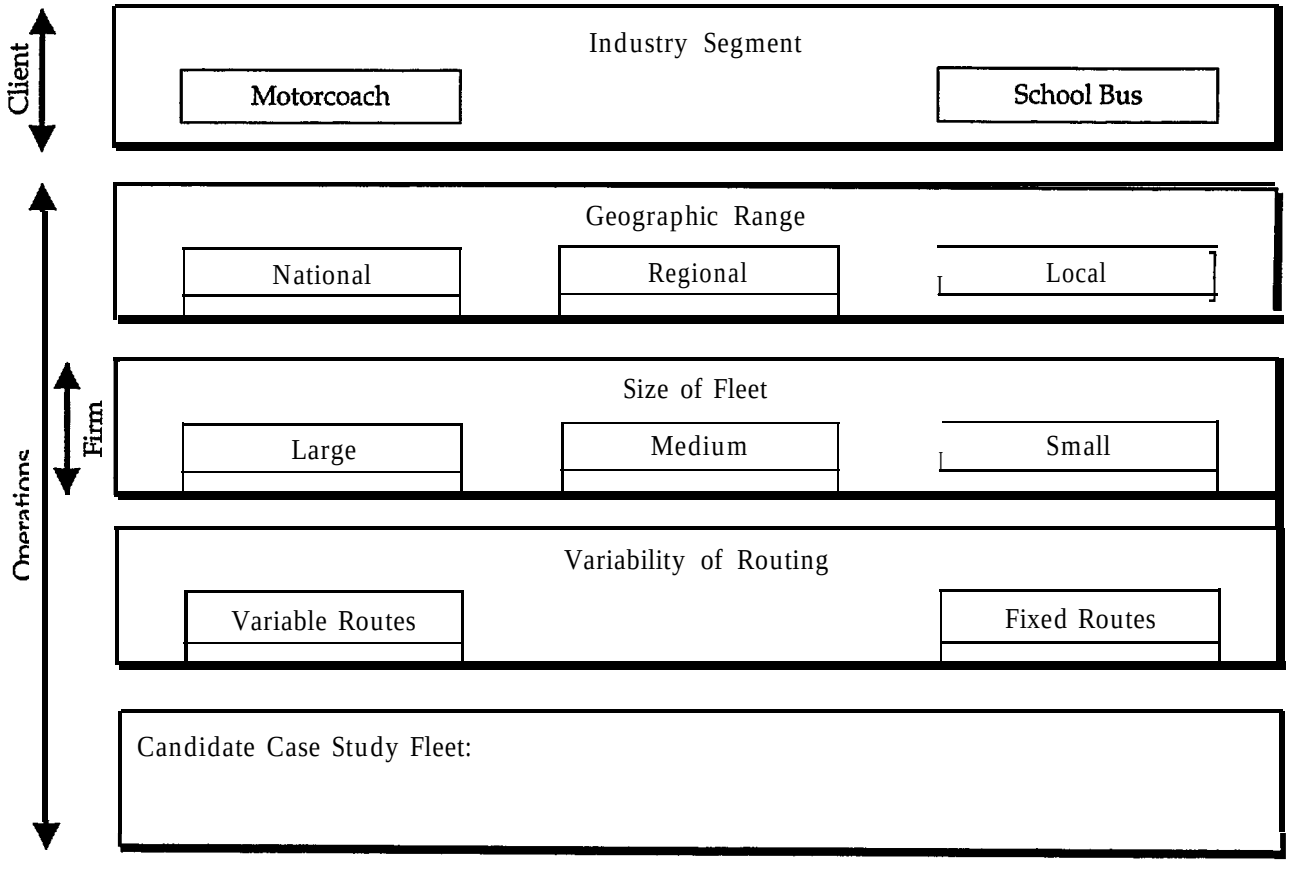


Figure 3B. Typology Profile Worksheet for Buses

5.0 ANALYSIS OF MOTOR CARRIER TYPOLOGIES

5.1 OVERVIEW

In this section, the new typology structure is used to analyze 4 commodities and 5 categories of use (i.e., industry segments) within the motor carrier industry. The data source for the analysis is discussed, along with the procedure by which individual trucks were selected from the main database for inclusion in the analysis. Typologies are provided for all of the commodities and industry segments analyzed, and 3 of the typologies are discussed in detail to provide representative examples.

5.2 MOTOR CARRIER INDUSTRY OVERVIEW

There are 44.6 million trucks registered in the United States; however, about 41 million of these, or about 92 percent of the fleet, are pickup trucks, panel trucks, minivans, and similar light trucks, many of which are used for personal transportation.[2] For traffic and congestion management purposes, these light trucks are indistinguishable from automobiles and are seldom counted as trucks. Light trucks will not be included in this analysis because it is assumed that the ITS market for light trucks will be very similar to the ITS markets for personal and commercial fleet automobiles.

The balance of the U.S. fleet, approximately 3.6 million trucks or about 8 percent of all trucks, are medium and heavy trucks, ranging from 4,540 kg (10,000 lb) local delivery trucks with 2 axles and 6 tires, to large, 36,320 kg (80,000 lb), over-the-road tractor semi-trailers with 5 axles and 18 tires. (The size classes used to categorize trucks as light, medium, or heavy are detailed in Figure 4.) About 400,000 of these trucks are off-road construction vehicles, daily rental vehicles, and trucks used for personal transportation. If these vehicles are subtracted from the total fleet, there are about 3.2 million large trucks that constitute the primary potential motor carrier market for fleet management ITS.

It is these large trucks (Classes 3 through 8) that are the primary focus of this analysis. They are significantly different from automobiles and light trucks because of their size, weight, and handling characteristics, the types of roads that they can use; and the business and safety regulations governing their use. More importantly, they account for most truck-miles of travel. As a group they are thought to account for over three-quarters of all truck-miles of travel and most of the ton-miles and revenue-miles of travel in urban areas.

These trucks are owned and operated in 870,000 fleets; however, the majority of these fleets are small – most are under 50 trucks, and many are under 5 trucks. It is estimated that only 4,000 out of the 870,000 fleets have more than 50 trucks. Although they do not account for many trucks, these larger fleets dominate the industry. It is estimated that the 2,000 largest motor carrier firms account for 80 percent of total industry revenues. This pattern of ownership and

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2/ United States Department of Commerce, Bureau of the Census, 1987 Truck Inventory and Use Survey, Washington, DC., 1990

Size Class	Weight Class	Gross Vehicle Weight (lbs)	Axles/Tires	Examples
Heavy-Heavy	8	>33,000	7/22+	Multi-trailer trucks
			6/18+	
			5/18	Tractor-semitrailers and doubles
			4/14	
			3/10	Concrete mixers and dump trucks
Heavy	7	26,000 - 33,000	3/10	City tractor with 28-foot pup trailer
Light-Heavy	6	19,500 - 26,000	2/6	Beverage truck
				Home heating fuel truck
	5	16,000 - 19,500	2/6	Stake truck
	4	14,000 - 16,000	2/6	Flat bed
Medium	3	10,000 - 14,000	2/6	Metro van (UPS)
	2	6,000 - 10,000	2/4	Step van (Mail)
Light	1	<6,000	2/4	Pickup truck, Van

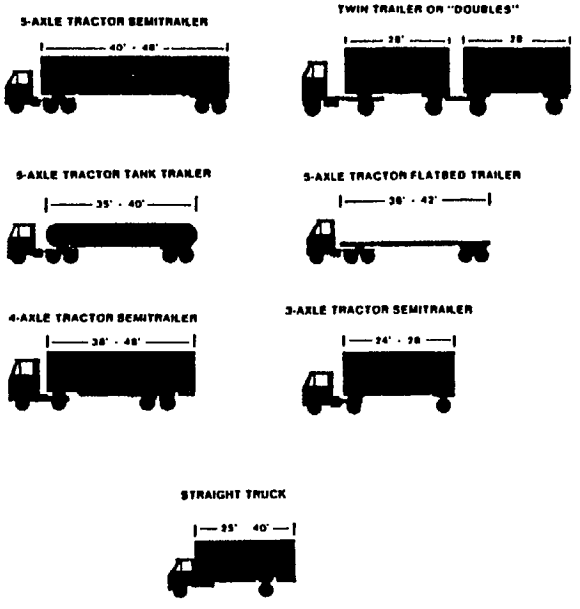


Figure 4. Truck Size Class Categories

operation – a few large fleets generating most of the industry revenues, and many small fleets operating most of the trucks – is very different from the pattern of ownership and operation of automobiles and light trucks, and will strongly influence the market for ITS technologies within the trucking industry.

The majority of the trucks in the analysis (about 80 percent), are in private fleets; that is, fleets owned and operated by a company to move its own products. Included in this group are trucks employed in local distribution activities, such as delivering gasoline to service stations, stocking supermarket shelves, and delivering retail goods to local stores and shopping malls. Other private trucks are employed in long-haul transportation, which typically involves moving products such as processed foods and manufactured goods between company production facilities and warehouses, or distributing products to retail stores. The remaining 20 percent of the trucks in this study are operated **by** for-hire motor carriers, providing common or contract carriage of freight and goods for other firms, usually manufacturers and retailers.

5.3 SAMPLE SELECTION METHODOLOGY

5.3.1 Data Source

The primary data source used in this analysis is the 1987 Truck Inventory and Use Survey (TIUS), published by the U.S. Census Bureau. The TIUS database is based on a stratified probability sample of trucks in every state. The total sample includes approximately 135,000 trucks out of an estimated "universe" of 44.6 million trucks. The sample is stratified by truck body type, as follows:

- Pickup;
- Van;
- Single-unit light;
- Single-unit heavy; and
- Truck tractor.

Within each state, a predetermined number of trucks from each stratum was randomly sampled. (The average number of trucks sampled per state was 2,653.) A weighting factor based on the actual number of truck registrations within each state and body type stratum was applied to each truck in the sample to produce an estimate for the total truck "universe."

5.3.2 Classification Methodology and Assumptions

The TIUS database contains information on truck's geographic ranges of operation and the sizes of the fleets in which they operate, but not on routing variability or the time-sensitivity of deliveries. Discussions were held with truck fleet operators from various segments of the trucking industry and with industry analysts to gather information about the nature of trucking

operations for each of the commodities analyzed. The information was used to make assumptions regarding route variability and time sensitivity; these assumptions guided the assignrnent of trucks to the different categories of these variables.

The methodology and assumptions used to assign trucks to particular categories vary with different product groups because each product group necessitates unique considerations. Therefore, the findings described in the following examples may not be directly transferable to other product groups.

5.3.3 Selection Criteria

The TIUS database contains information on numerous classes of trucks, including many trucks that are not appropriate for inclusion in this study. To limit the analysis to appropriate truck categories, the following selection criteria were used (see Figure 5):

- Trucks with a gross weight of over 4,540 kg (10,000 lb).
- Trucks operated by and for private businesses (i.e., private fleets), or for hire.
- **Trucks** operating on public roads and highways.

The entries meeting these criteria were extracted from the main TIUS data file for further analysis. Analyses were conducted for a total of 4 commodities and 5 industry groups. The selection of commodities and industries is not intended to be exhaustive; it is designed to present a representative cross-section of the trucking industry, and to encompass a variety of different trucking operations.

Commodities

- **Liquid Petroleum** (including, for example, gasoline, diesel fuel, heating oil, and aviation fuel, but excluding paving and roofing products such as tar): approximately 109,000 trucks selected for analysis.
- **Building Materials** (including, for example, sand, gravel, concrete and flat glass, but excluding lumber): approximately 492,800 trucks selected for analysis.
- Processed foods (including, for example, canned foods, frozen foods, prepared meats, beverages and dairy products, but excluding grain, produce, livestock and raw milk): approximately 290,000 trucks selected for analysis.
- **Moving of Household and Office Goods (including,** for example, furniture and office equipment): approximately 58,000 trucks selected for analysis.

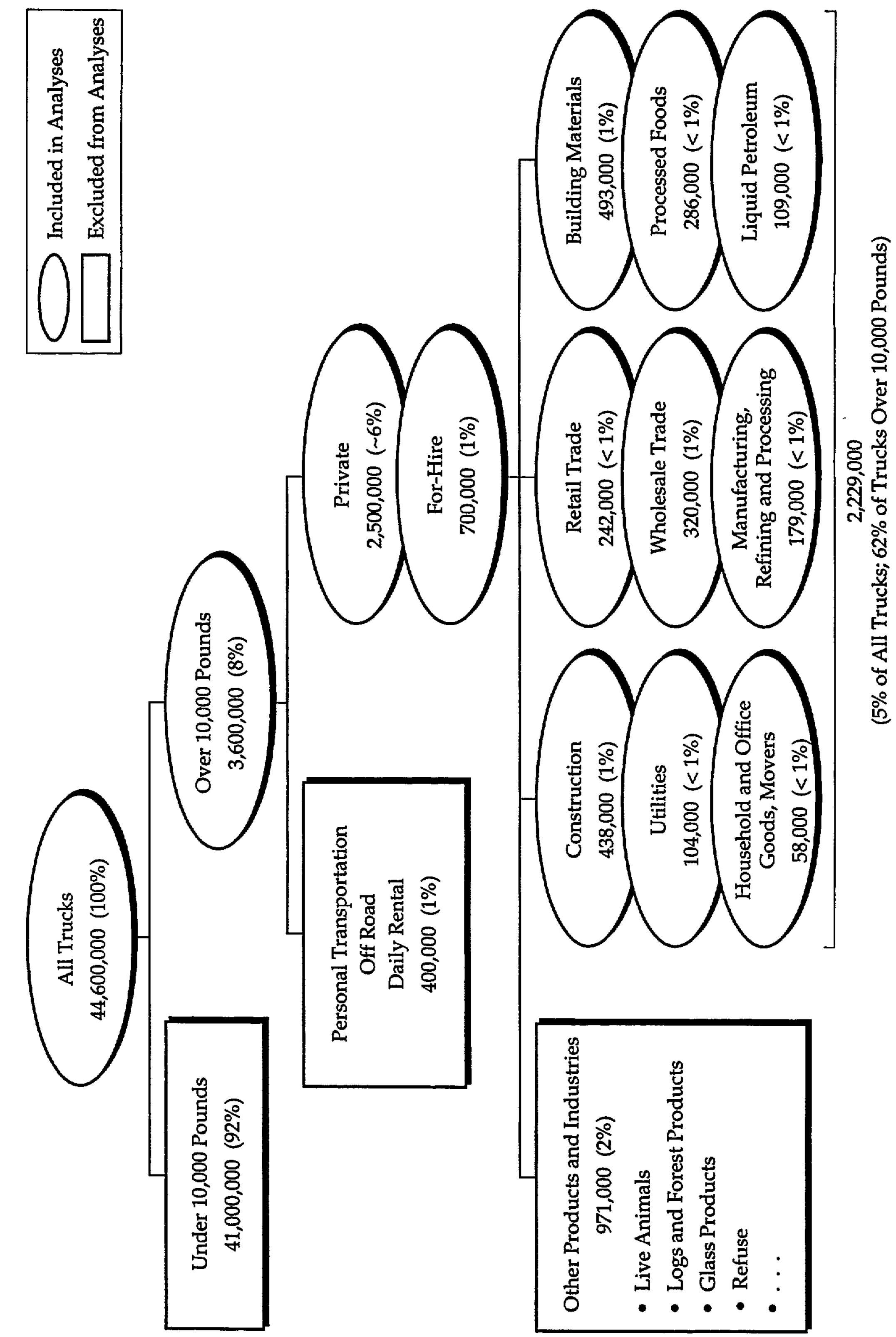


Figure 5. Commercial Motor Carrier Industry Market Segmentation Analysis: Sample Selection

Industries

- **Manufacturing, Refining, and Processing:** approximately 179,100 trucks selected for analysis.
- **Wholesale Trade:** approximately 320,400 trucks selected for analysis.
- **Retail Trade:** approximately 241,600 trucks selected for analysis.
- **Construction:** approximately 438,300 trucks selected for analysis.
- **Utilities:** approximately 104,400 trucks selected for analysis.

5.4 SELECTED TRUCKING INDUSTRY SEGMENT TAXONOMY DESCRIPTIONS

The following sections provide descriptions of the typologies for 3 major commodities. These descriptions are intended to serve as representative examples of the ways that the typologies can be used to analyze the trucking industry. In addition, the descriptions communicate the kinds of factors that were considered in the analyses. It is important to remember that each commodity and industry in unique; the findings for one may not transfer directly to others. Figures illustrating the other 6 commodities and industries analyzed are included as well (Figures 9 through 14).

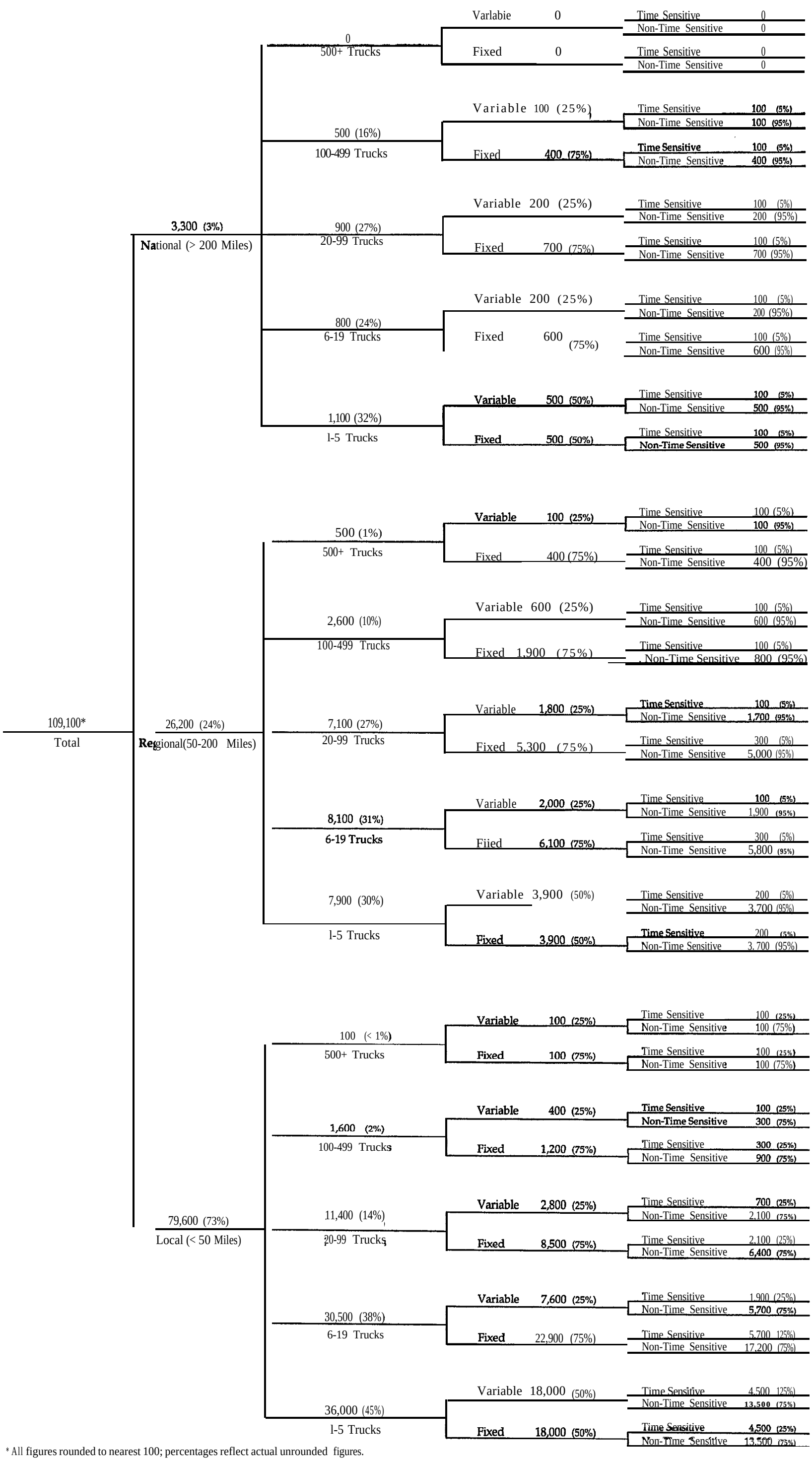
5.4.1 Liquid Petroleum

The majority of petroleum tankers operate locally, in small fleets. Most tankers are on fixed routes, and most of their deliveries are not time sensitive.

Geographic Range and Fleet Size

Approximately 109,000 tankers move liquid petroleum products in the United States (Figure 6). Of this total, nearly 75 percent (approximately 80,000) operate at the local level [i.e., within 80.5 km (50 miles) of their home bases]. These local operators are primarily home heating oil distributors and gasoline tankers supplying service stations within metropolitan areas. Almost all of the remaining petroleum tankers operate regionally [i.e., at a range of 80.5 km to 322.0 km (50 to 200 miles) from their home bases]. It can be assumed that these tankers are principally moving products from regional supply facilities to service stations, heating oil dealers, and other local destinations.

The majority (83 percent) of local petroleum tankers operate in fleets of fewer than 20 trucks. At the regional level, trucks are more uniformly distributed among the different fleet size categories.



* All figures rounded to nearest 100; percentages reflect actual unrounded figures.

Figure 6. Liquid Petroleum (Trucks Over 10,000 Pounds)

Route Variability and Time Sensitivity

It can be assumed that the majority of petroleum delivery routes are fixed. Most tankers make the same deliveries, in the same order, on a regular schedule. When we consider how differences in fleet size might affect route variability, however, some differences emerge. Companies with large fleets may be able to assign specific trucks to specific routes, thereby maintaining fixed routes. Companies with small fleets do not have this option; they must dispatch trucks in a more variable fashion one route one day, a different route the next. Thus, it is estimated that, in fleets of more than 5 trucks, 75 percent of the trucks operate on fixed routes, whereas in fleets with 5 trucks or fewer, 50 percent of the routes are fixed.

Petroleum is not a particularly time-sensitive commodity because it is always stored in large quantities and can be held for long periods. Therefore, it can be assumed that petroleum tankers have a fairly flexible delivery schedules; in most cases, a delay of 1 or 2 days will not create critical problems. The exception to this is home heating oil dealers, who, during winter months, frequently respond to emergency calls from residential customers who have used up their oil before their regular delivery date. In these cases, petroleum delivery is highly time sensitive. Thus, it is assumed that 25 percent of local petroleum deliveries are time sensitive, while only 5 percent of regional and national petroleum deliveries are time sensitive.

5.4.2 Processed Foods

Processed foods trucks are fairly evenly distributed among different fleet sizes. Slightly less than half of these trucks operate locally; about 30 percent operate regionally and about 20 percent operate nationally. The routing of trucks operating nationally and regionally is more variable than is the routing of local trucks.

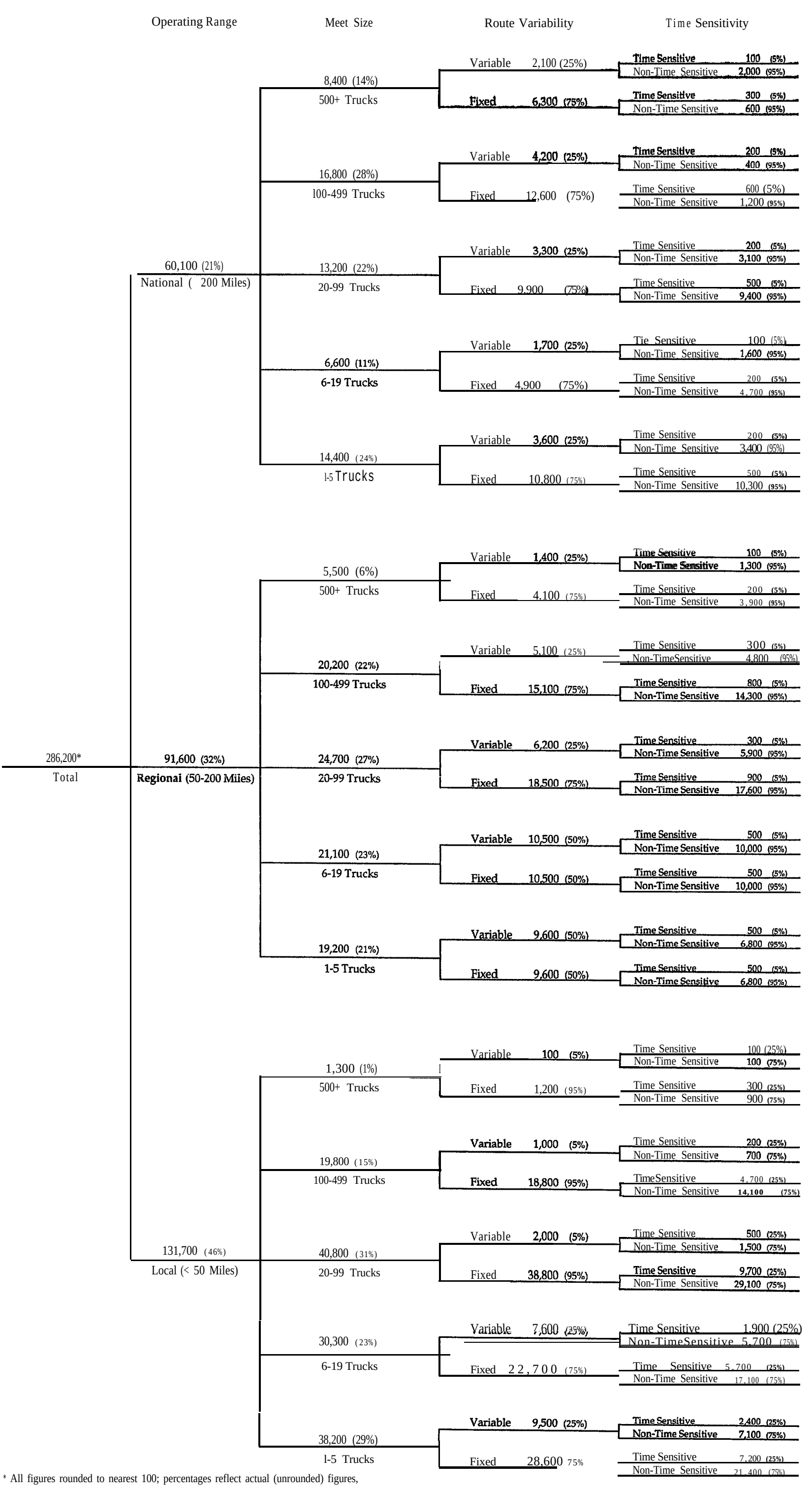
Geographic Range and Fleet Size

Nationwide, approximately 290,000 truck are carrying processed foods (Figure 7). Slightly fewer than half (approximately 130,000) of these trucks operate locally, while about one-third (approximately 95,000) operate regionally, and about one-fifth (approximately 62,000) handle long-haul (national) shipments.

Overall, these trucks are fairly evenly distributed among the various fleet size categories. In contrast to petroleum tankers, which operate mainly in small fleets, 26 percent of processed food trucks operate in fleets with 100 or more vehicles.

Route Variability and Time Sensitivity

Based on conversations with food distributors, it is assumed that a large percentage of the processed food trucks operating nationally and regionally are engaged in moving truck loads of single (or highly similar) products from production facilities (e.g., canning, freezing and bottling plants) to warehouse and distribution facilities. On the local level, however, it can be assumed that each truck carries a variety of different processed foods to stores. Because of this



* All figures rounded to nearest 100; percentages reflect actual (unrounded) figures,

Figure 7. Processed Food (Trucks Over 10,000 Pounds)

difference in the composition of cargo, the routing of local trucks is less variable than that of national or regional trucks.

When processed food producers alter their production schedules because of fluctuating demand or seasonal variations, this may cause the routing and scheduling of regional and national truck-load carriers to change, but production changes are less likely to affect the routing of local trucks. Instead, the composition of local trucks' loads may change. For example, although long-haul and regional movements of canned fruits from California may increase sharply during the summer, this does not mean that local delivery routes or schedules will change; if anything, local trucks simply may carry more canned fruit during summer months.

For the same reasons that petroleum tankers in small fleets experience greater variability than tankers in larger fleets, processed food trucks operating in smaller fleets may have more variable routing than those in large fleets: smaller fleets may be less able to dedicate trucks to specific routes. Thus, we estimate that among regional and national fleets, the percentage of trucks operating on variable routes ranges from 25 percent among the larger fleets (20 or more trucks), to 50 percent among the smaller fleets (fewer than 20 trucks). At the local level these estimates change slightly; 5 percent of trucks in large fleets, and 25 percent of trucks in small fleets operate on variable routes.

Most processed foods have relatively long shelf lives, and are typically stored in large quantities. In general, therefore, deliveries of processed foods are not highly time sensitive. On the local level, however, a large number of deliveries are of time-sensitive foods with a short shelf life (e.g., milk and bread) which must be delivered on a frequent or daily basis. Consequently, we estimate that only 5 percent of processed food trucks operating regionally and nationally are making time-sensitive deliveries, while 25 percent of locally operating processed food trucks are making time-sensitive deliveries.

5.4.3 Building Materials

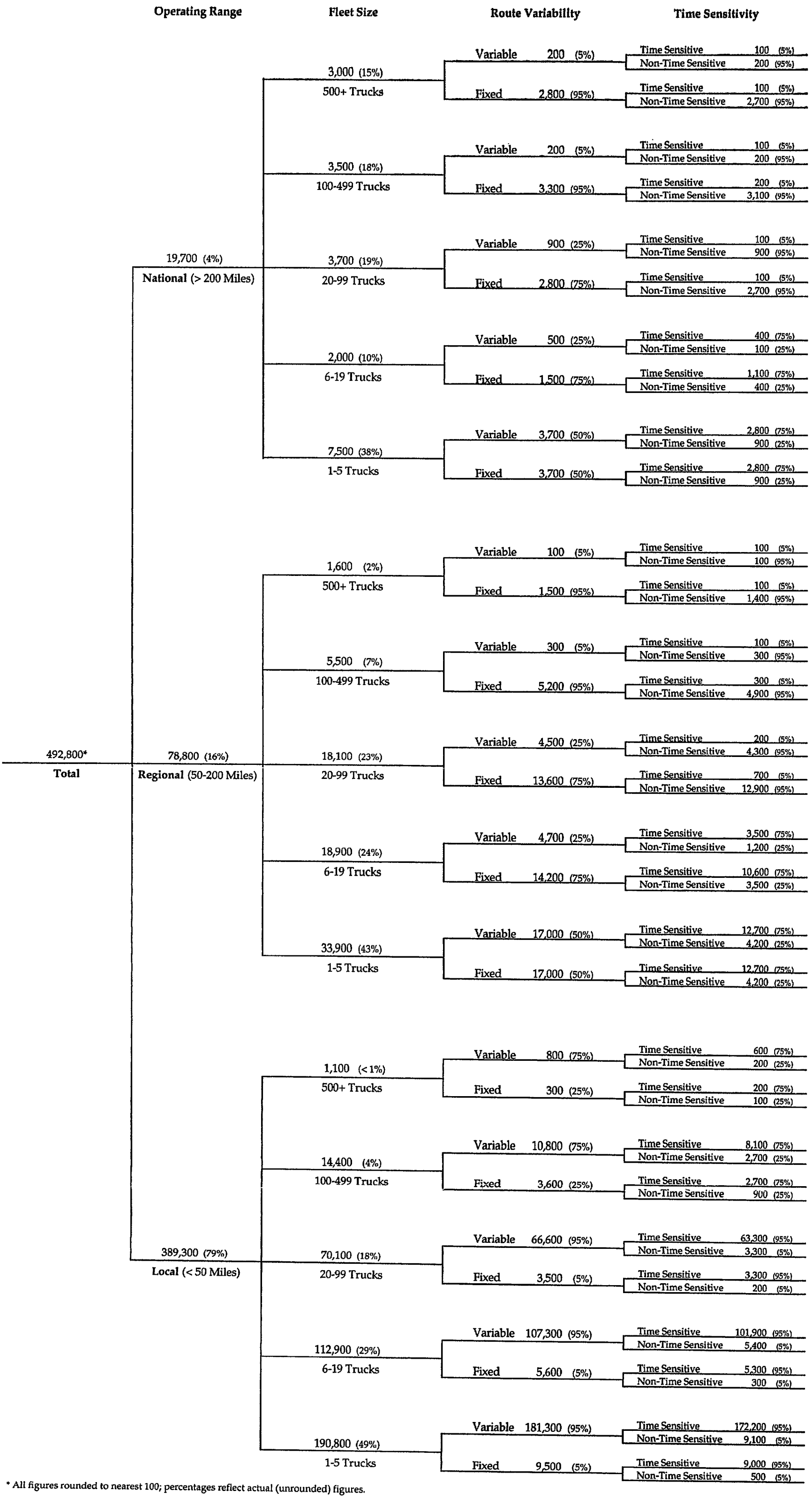
Small (under 20 power units), local fleets dominate the building materials segment. Local operations are more variable and more time sensitive than regional or national operations.

Geographic Range and Fleet Size

There are just under 500,000 trucks carrying building materials nationwide (Figure 8). Nearly 80 percent (approximately 395,000) of these trucks operate locally. At every level of geographic range, small fleets are dominant. For example, over 75 percent of the trucks that operate locally do so in fleets with fewer than 20 power units.

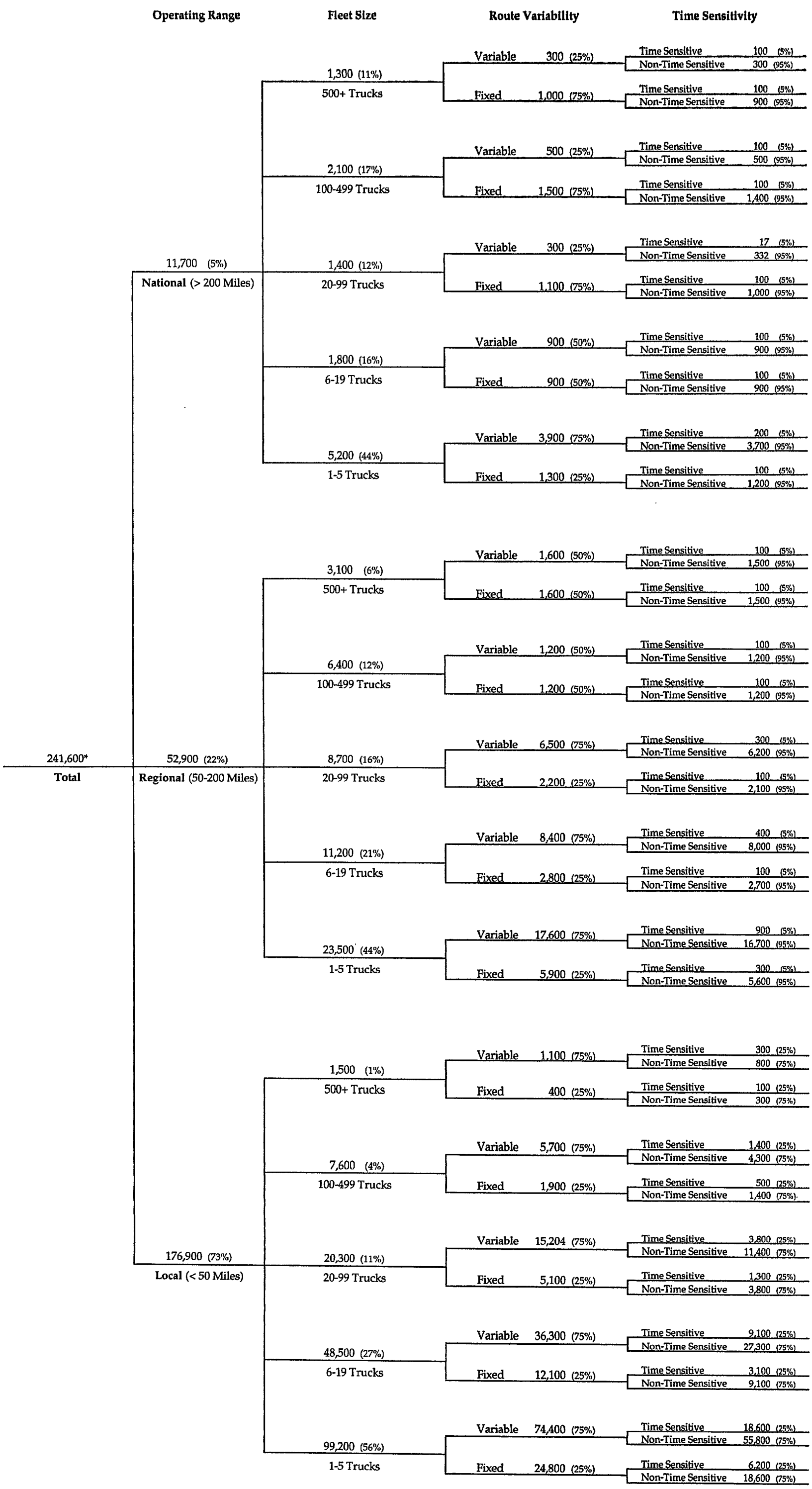
Route Variability and Time Sensitivity

Trucks carrying building materials at the national and regional levels tend to operate on mostly fixed routes. These trucks are primarily delivering materials to storage and distribution facilities, rather than to individual construction sites. At the local level, the situation essentially reverses; most trucks are delivering to individual construction sites, and, hence, operate on



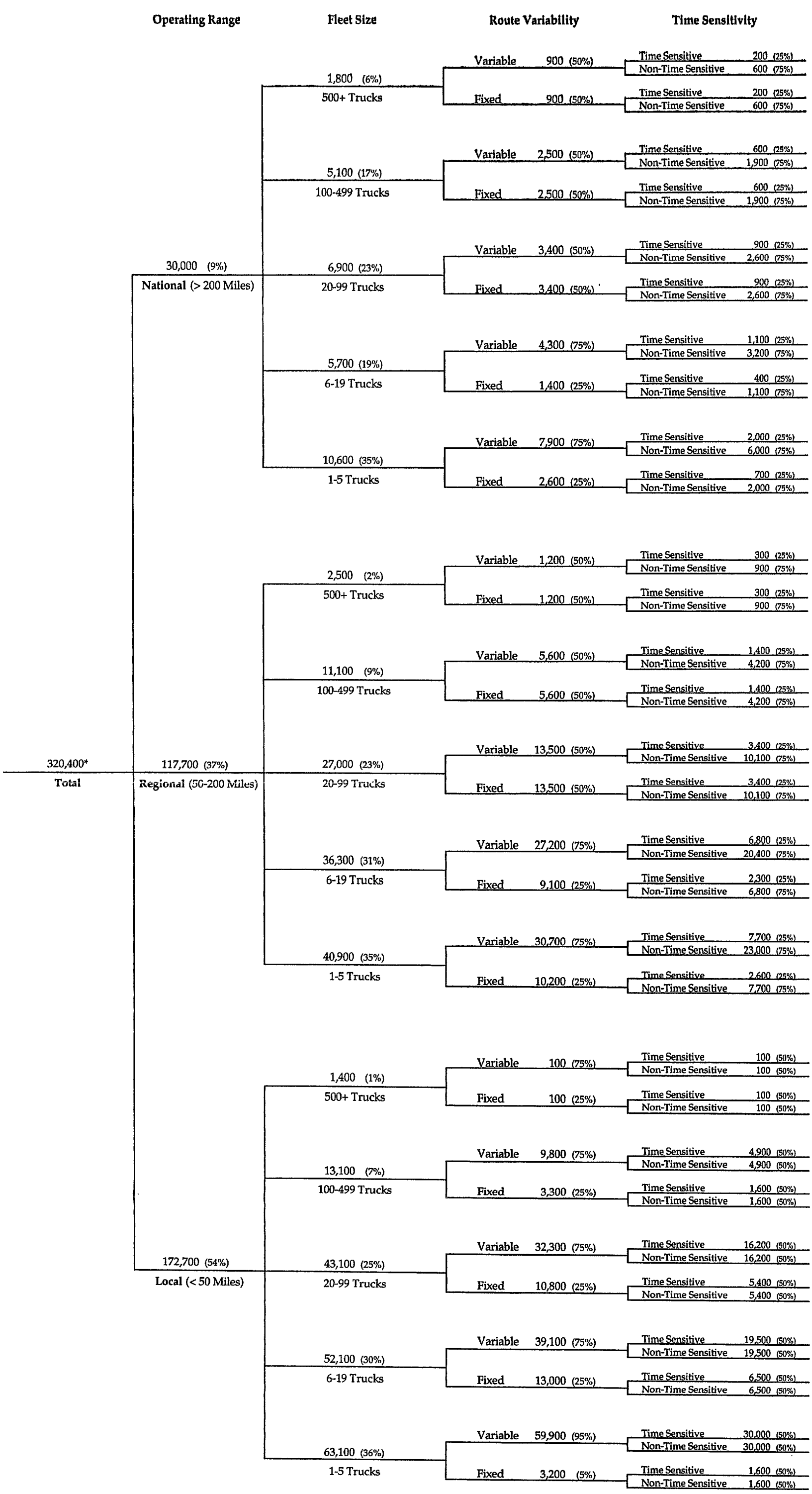
* All figures rounded to nearest 100; percentages reflect actual (unrounded) figures.

Figure 8. Building Materials (Trucks Over 10,000 Pounds)



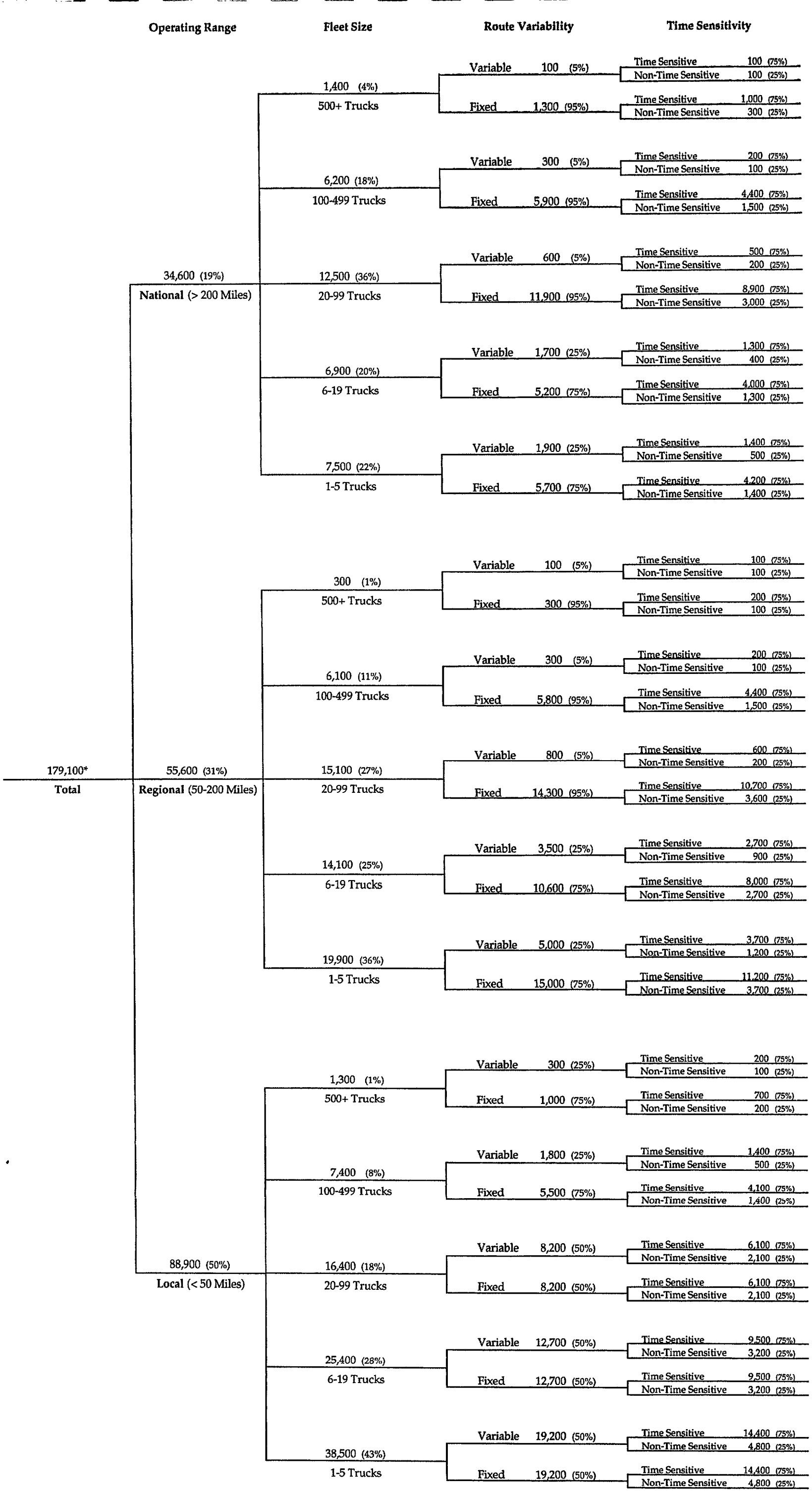
* All figures rounded to nearest 100; percentages reflect actual (unrounded) figures.

Figure 9. Retail Trade (Trucks Over 10,000 Pounds)



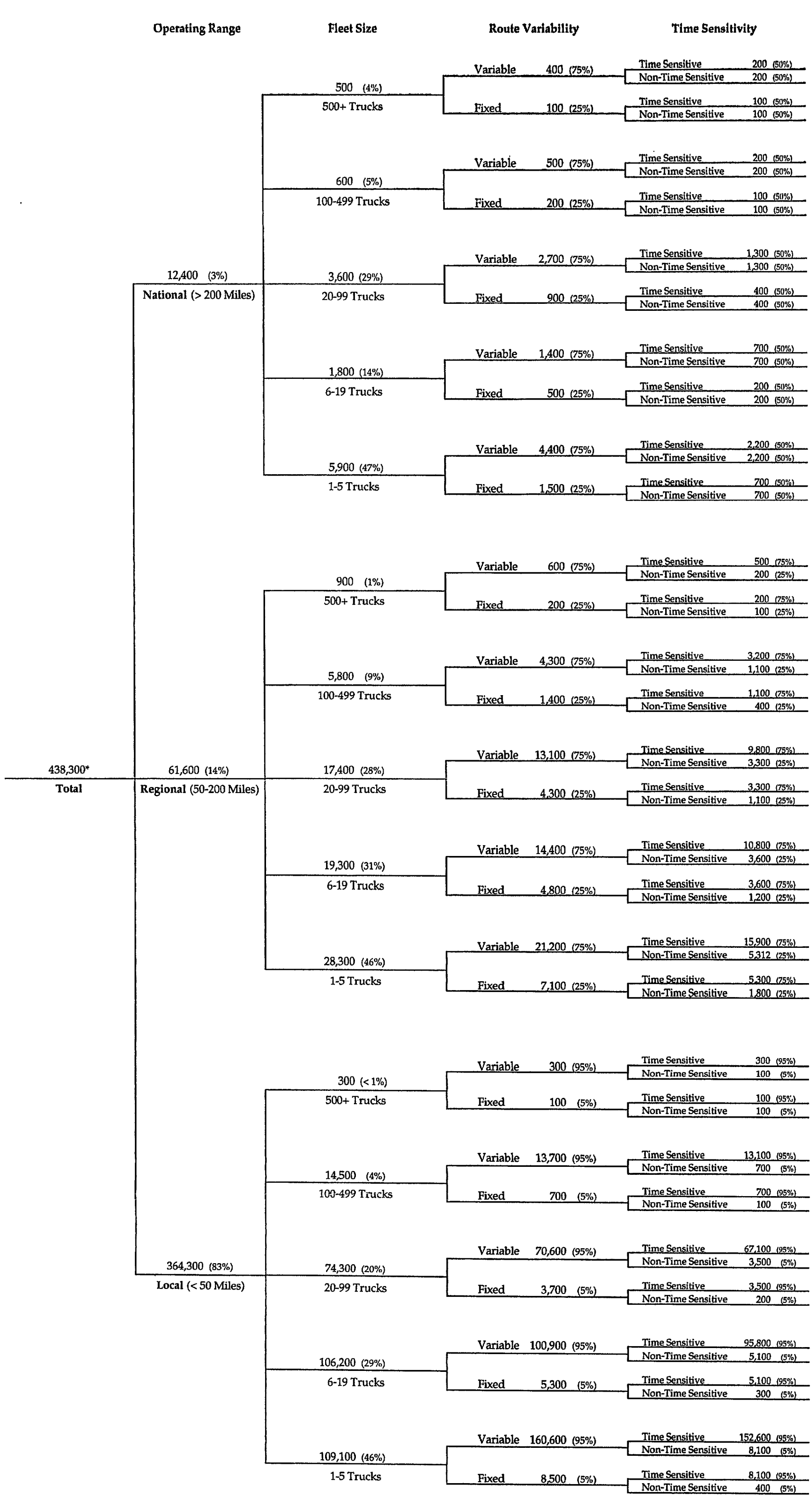
* All figures rounded to nearest 100; percentages reflect actual (unrounded) figures.

Figure 10. Wholesale Trade (Trucks Over 10,000 Pounds)



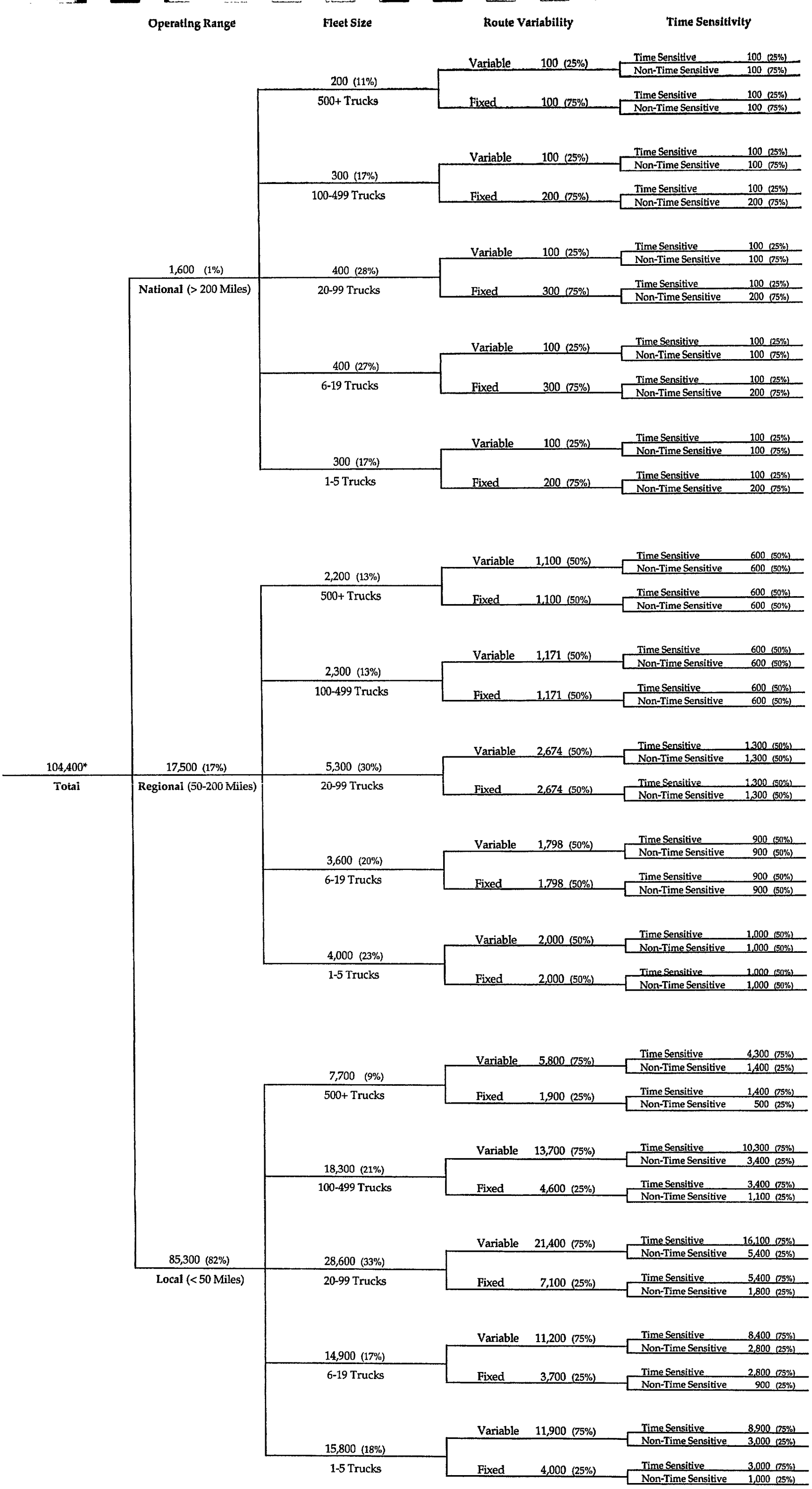
* All figures rounded to nearest 100; percentages reflect actual (unrounded) figures.

Figure 11. Manufacturing, Refining and Processing (Trucks Over 10,000 Pounds)



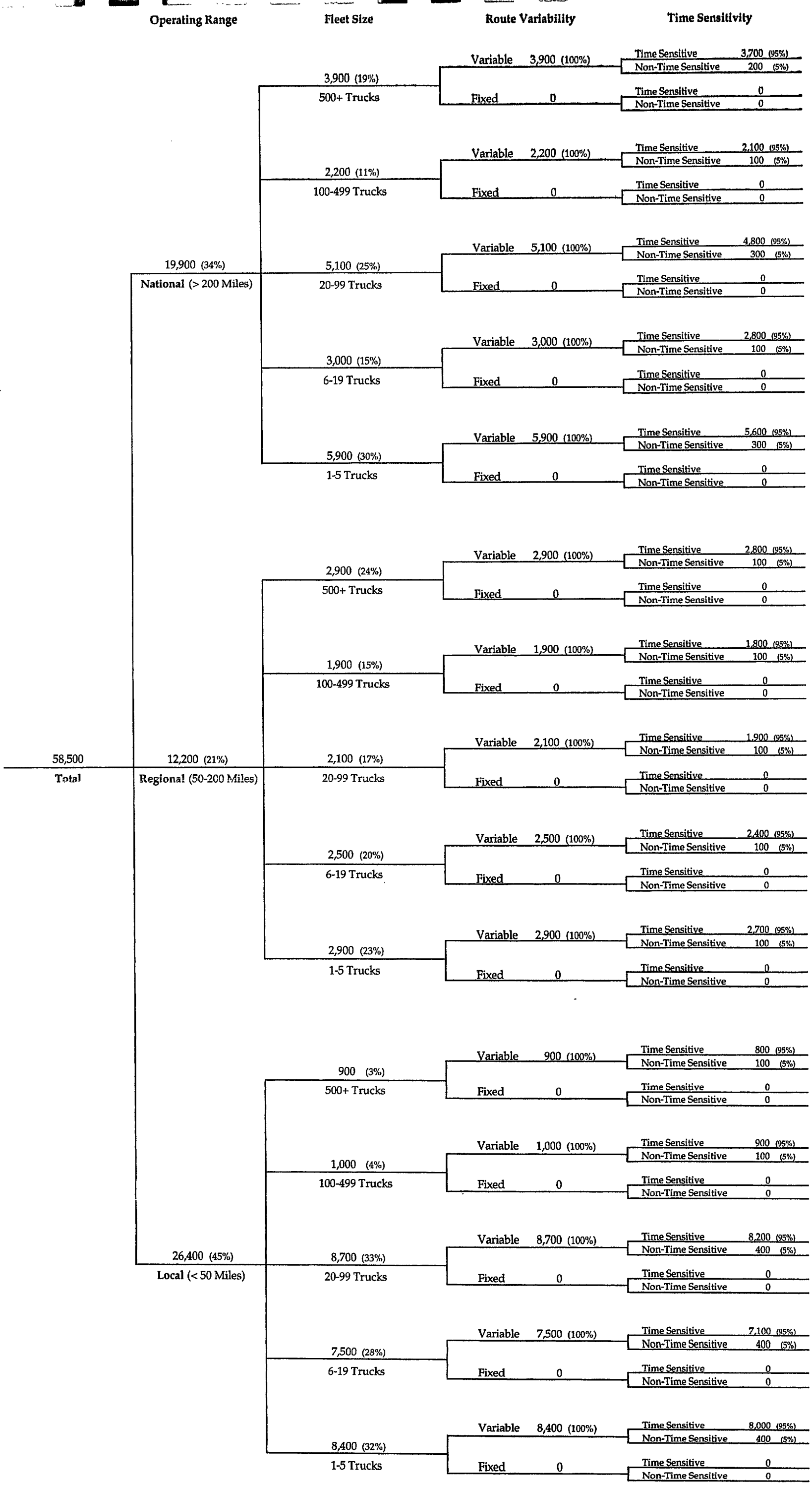
* All figures rounded to nearest 100; percentages reflect actual (unrounded) figures.

Figure 12. Construction (Trucks Over 10,000 Pounds)



* All figures rounded to nearest 100; percentages reflect actual (unrounded) figures.

Figure 13. Utilities (Trucks Over 10,000 Pounds)



* All figures rounded to nearest 100; percentages reflect actual (unrounded) figures.

Figure 14. Household, Office Goods, and Moving Companies (Trucks Over 10,000 Pounds)

highly variable routes. As with petroleum and processed foods, smaller fleets may experience higher route variability than do larger fleets. Thus, we estimate that at the national and regional levels, 5 percent of building materials trucks in large fleets (100 or more trucks) operate on variable routes, and 25 percent of trucks in smaller fleets (fewer than 100 trucks) operate on variable routes. We estimate that at the local level 75 percent of trucks in large fleets and 95 percent of trucks in smaller fleets operate on variable routes.

It can be assumed that national and regional deliveries of building materials are not time sensitive because these materials are generally stockpiled in large quantities. At the local level, trucks are primarily delivering building materials to individual construction sites, so delivery routes may change weekly or even daily. Furthermore, since a late delivery of building materials to a construction site may delay the entire job, local delivery of building materials is highly time sensitive. Thus, we estimate that at the national and regional levels, 5 percent of building materials trucks in large fleets and 25 percent of trucks in smaller fleets are making time-sensitive deliveries. Locally, 75 percent of trucks in large fleets and 95 percent of trucks in small fleets operate on time-sensitive schedules.

6.0 PROPOSED CASE STUDY CANDIDATE FLEETS

6.1 CRITERIA FOR SELECTION

Time and budget limitations do not permit a detailed analysis of all of the many diverse truck and bus operations that exist in the United States; therefore, a sample is needed. The selection of a representative sample can be facilitated by applying the typology structure described previously. In addition, the following major considerations guide the selection of the case study candidates: size, which is correlated with the magnitude of potential benefits and costs of fleet management technology; and specialization, which may imply unique needs for such technology regardless of fleet size. The criteria for case study selection may be expressed as follows for the trucking industry:

- Does the carrier represent a major segment of the motor carrier industry? Are all of the major industry segments adequately represented among the fleets selected as case studies?

- Is the carrier a bellwether for its segment of the industry? Is the carrier an early technology adopter? Has the carrier demonstrated a **capability** to implement new technologies in a way that is indicative of how the industry will behave over the next 5 to 10 years?

- Is the carrier willing to participate in the study? Are the carrier's managers likely to be open and forthcoming about their firm's fleet management needs and the costs and benefits of implementing ITS technology?

The selected firms also must be representative in terms of geography (i.e., the firms must be distributed nationwide, rather than concentrated in 1 or 2 regions of the country). In addition, there should be an appropriate distribution among private, for-hire, and bus fleets.

6.2 RECOMMENDATIONS FOR CASE STUDIES

Profiles were developed for more than 20 candidate truck fleets and 11 candidate bus fleets using the worksheet format. From these profiles, based on the typology analyses and on the project team's judgement, 13 fleets have been selected as a representative sample of major fleet types and are recommended as candidates for in-depth case studies (pending the agreement of the firms to participate in the study). The characteristics of the firms selected are summarized in Figure 15. In addition to these "prime" candidates, we also will conduct interviews with "secondary" firms in several of the major segments as time and budget permit.

The following firms have been selected as primary case study candidates:

- **Flour Transportation** (Maywood, California) – A regional for-hire carrier specializing in truckload shipments of bulk commodities (i.e., flour). Time-sensitive deliveries, on mostly fixed routes. Flour operates 30 power units and 46 trailers, and had revenues of approximately $5 million in 1990.

		Area of Operation			Fleet Size			Routing Variability		Time Sensitivity of Shipments	
Candidate	**Product or Industry Segment**	**Local**	**Regional**	**National**	**Small**	**Medium**	**Large**	**Fixed**	**Variable**	**Time-Sensitive**	**Non-Time-Sensitive**
Flour Transportation	Bulk Commodities		●			●		●		●	
Amoco Oil	Petroleum	●			●				●		●
Mayflower Transportation	Household Movers										
Pennsylvania Truck Lines	Intermodal Drayage		●				●		●		●
Roadway Express	Mixed Freight			●			●		●	●	●
Swift Transportation	Manufacturing		●				●		●	●	
Chemical Leaman	Chemicals			●			●	●			●
Leprino Foods	Processed Foods			●			●	●			●
Associated Grocers	Food Distribution		●			●		●			●
Boston Sand and Gravel	Construction Materials	●				●			●	●	●
Kerrville Bus Company	Bus Line		●			●		●		●	
Georgia Power Company	Public Utility		●			●			●		●
New Hampshire Turnpike Authority	Government Fleet	●			●				●		●

Figure 15. Recommended Primary Case Study Candidates: Fleet Characteristics

- **Amoco Oil** (Doraville, Georgia division) – A local private fleet of petroleum tankers. Non-time-sensitive deliveries, on variable routes. Amoco Oil operates about 10 power units and serves 250 customers in Georgia.

- **Mayflower Transportation** (Carmel, Indiana) – A national for-hire household goods mover (also hauls some general freight). Mayflower operates 2,100 power units on variable routes, with mostly non-time-sensitive shipments. Mayflower has approximately $300 million in gross freight revenues in 1993.

- **Pennsylvania Truck Lines** (Conshohoken, Pennsylvania) – A regional for-hire intermodal carrier providing general freight drayage on variable routes, with mostly non-time-sensitive shipments. Pennsylvania Truck Lines operates 440 power units and had revenues of $87 million in 1990.

- **Roadway Express** (Akron, Ohio) – A national for-hire mixed-freight hauler. Roadway Express operates 10,063 power units and 33,783 trailers on variable routes, with some time-sensitive and some non-time-sensitive shipments. The carrier had $2.3 billion in gross freight revenues in 1993.

- **Swift Transportation** (Phoenix, Arizona) – A mostly regional for-hire mixed-freight carrier. Swift Transportation operates 2,300 power units and 4,695 trailers on variable routes, with time-sensitive shipments. The carrier had gross freight revenues of $266 million in 1993.

- **Chemical Leaman Tank Lines** (Exton, Pennsylvania) – A national private chemical hauler (the nation's largest bulk motor carrier). Chemical Leaman operates 1,424 power units and 2,372 tanker-trailers on mostly fixed routes, with non-time-sensitive shipments and had $222 million in gross freight revenues in 1993.

- **Leprino Foods** (Denver, Colorado) – A national, private line-haul food manufacturer and distributor. Leprino Foods operates 135 power units and 213 trailers on variable and fixed routes, with non-time-sensitive shipments, and had $22 million in gross freight revenues in 1993.

- **Associated Grocers** (Seattle, Washington) – A mostly regional, private-fleet food distributor. Associated Grocers operates 42 power units, 240 trailers and 5 single-unit trucks on fixed routes with non-time-sensitive shipments. (Revenue data not available.)

- **Georgia Power Company (Atlanta, Georgia)** – A public utility with a fleet of over 6,500 vehicles. Regional medium-sized fleets operating on variable routes, with non-time-sensitive shipments.

- **Boston Sand and Gravel** (Boston, Massachusetts) or similar urban construction industry fleet.

- **Kerrville Bus Company** (Kerrville, Texas) – A privately owned and operated regional bus fleet, with 189 power units (of which 179 are over 40 feet in length) operating on both fixed and variable routes.

- **State of New Hampshire Turnpike Authority** (or similar state fleet) – Massachusetts Turnpike Authority fleet or a State Department of Transportation fleet are likely substitutes.

APPENDIX A
CASE STUDY INTERVIEW MATERIALS

PRIVATE MOTOR CARRIER INTERVIEW QUESTIONS

I. INTRODUCTION

Describe purpose of study and interview.

II. DEFINE FLEET OPERATION

A. Fleet Characteristics

1. How many power units does your company operate?

2. How many of the power units does your company own vs. lease?

3. How many trailers does your company own vs. lease?

4. What types of trailers do you operate (e.g., refrigerated vs. dry)?

5. How many drivers does your company employ?

6. How many are company employees vs. contract or leased?

7. What is the union status of the drivers that operate your trucks?

8. How many / what types of facilities does your company operate?

9. Where are these facilities located?

10. Provide an overview of your company's maintenance program (is this done in-house or out-sourced)? If maintenance is out-sourced, what are the advantages / disadvantages of this approach?

11. What is the criteria for replacing vehicles? What is the average age of the power units / trailers in your fleet?

12. If company leases power units or trailers, why have they chosen to do this? Have they conducted any cost-benefit analyses that justifies this approach?

B. Nature of Operations

1. What type(s) of products does your company transport?

2. Explain the role that your fleet of trucks plays in serving internal and external customers

3. What is your company's operational approach (e.g., backhaul driven vs. outbound driven)?

4. If your company provides backhaul service describe how this is marketed to potential customers.

5. If your company provides backhaul service, who are your primary customers, where are they located, how many in total?

6. What are the delivery parameters for backhaul services that your fleet provides?

7. What are the penalties associated with non-performance?

8. What are the delivery parameters for your primary customers?

9. What are the penalties associated with non-performance?

10. How does your company target perspective customers?

11. How does your company market itself? What are your selling points?

12. What is your customer retention level?

13. Who from your company comes into contact with the customers (i.e., drivers, dispatchers, other company representatives)?

14. What operating or other productivity ratios does your company track?

15. Please provide an overview of your company's financial performance.

C. Driver Management

1. How are drivers compensated (e.g., per hour, load, etc.)?

2. What type of incentives does your company offer to drivers?

3. How would you describe your company's approach to quality of life issues with respect to drivers? How has this impacted driver retention?

4. What type of interaction is their between drivers and management? Is this considered to be important at your company?

5. What training does your company offer drivers (e.g., safety, etc.)? What is your company's philosophy about driver training?

D. Regulatory Compliance

1. Who is responsible for tracking drivers hours-of-service and other driver-related requirements?

2. Who is responsible for tracking information on individual vehicles (e.g., maintenance information, mileage, etc.)?

3. Who is responsible for obtaining vehicle / driver credentials?

4. What type of system(s) is being used to track this information (e.g., paper vs. data base)?

III. INDUSTRY SEGMENT DISCUSSION

1. How many carriers would you estimate are in your industry segment?

2. Break this down into local, regional, and national.

3. How do you think they vary with respect to range of operation?

4. How do you think they vary with respect to time sensitivity of shipments?

5. How do you think they vary with respect to route variability?

6. How do you think they vary with respect to fleet size (power units and trailers)?

7. In general, do you think most companies lease or own the equipment that they are operating?

8. How many drivers do most companies in your industry segment employ? Are most of the drivers company employees or contract drivers?

9. How profitable are most motor carriers in your industry segment?

IV. ROUTING/DISPATCHING DISCUSSION

A. "Walk Through" of Routing and Dispatching Process

1. What are the critical elements involved in the routing / dispatching process?

2. What type of information is being used for routing / dispatching?

3. How are unforeseen problems handled? For instance if a truck breaks down while moving a load.

4. Does the dispatcher maintain contact with drivers while they are in transit? If yes, what is the purpose of this communication?

5. If trucks are based at more than one location, is there more than one person responsible for routing and dispatching? If yes, are routing/dispatching activities coordinated?

6. How much slack time does the dispatcher usually have to work with?

7. What are the greatest day-to-day frustrations with respect to routing and dispatching?

V. CORPORATE MANAGEMENT SYSTEMS

A. Fleet Management

1. What hardware and software is currently being used to support fleet routing and dispatching? If more than one location is used for routing/dispatching, are the same systems being used?

2. When was the technology that you are currently using installed?

3. What are the strengths and weaknesses of the hardware/software?

4. What on-board systems are used for communication or record keeping?

5. When was this equipment installed?

6. What are the strengths and weaknesses of this equipment?

7. What systems were previously used? What prompted the decision to change/upgrade?

8. Has your company conducted cost-benefit analysis to determine the impact that this technology has had on fleet efficiency or operating cost savings?

9. If yes, please describe the analysis that was conducted. What were the units of measurement that were used (e.g., per truck, etc.)?

10. How does this technology relate to your ability to better serve customers?

11. Does the technology give your company a strategic advantage over your competitors?

B. Other Management Systems

1. Provide a brief overview of the other MIS that your company uses

2. What hardware/software is being used to support these systems?

3. Is the fleet management hardware/software compatible with these other systems?

C. Relationship between Fleet Management Technology and other MIS

1. How does the fleet management system relate to other MIS?

2. What type of information is exchanged among systems or other company functional areas?

3. Describe your company's fleet budgeting practices. How does this process relate to other budgeting and accounting functions?

4. What are the limitations of the existing system?

VI. FUTURE ROUTING/DISPATCHING AND TECHNOLOGY

A. Anticipated Changes to Industry Environment Impacting Fleet Management

1. How will your customers needs change over the next decade?

2. Do you anticipate that your company will be providing the same services in the foreseeable **future? If** no, **how** do you **see this** changing?

3. If changes are expected how will this impact fleet management practices?

4. How will information needs change over the next few years?

5. What impact will technology advances have **on** your company and your competitors?

6. Do you see your company as an industry leader or follower with respect to the use of technology?

B. Anticipated Technology Advances

1. Do you anticipate any changes to the routing/dispatching system that is currently being utilized?

2. Anticipated changes to other corporate MIS which may impact fleet management?

C. Opportunities for Technology Applications

1. What equipment is available that you would like to be using now?

2. How would this benefit your operation?

3. What additional information would you like to have access to (e.g., congestion, road closures, etc.)?

FOR-HIRE MOTOR CARRIER INTERVIEW QUESTIONS

I. INTRODUCTION

Describe purpose of study and interview.

II. DEFINE FLEET OPERATION

A. Fleet Characteristics

1. How many power units does your company operate?

2. How many of the power units does your company own vs. lease?

3. How many trailers does your company own vs. lease?

4. What types of trailers do you operate (e.g., refrigerated vs. dry)?

5. How many drivers does your company employ?

6. How many are company employees vs. contract or leased?

7. What is the union status of the drivers that operate your trucks?

8. How many / what types of facilities does your company operate?

9. Where are these facilities located?

10. Provide an overview of your company's maintenance program (is this done in-house or out-sourced)? If maintenance is out-sourced, what are the advantages / disadvantages of this approach?

11. What is the criteria for replacing vehicles? What is the average age of the power units / trailers in your fleet?

12. If company leases power units or trailers, why have they chosen to do this? Have they conducted any cost-benefit analyses that justifies this approach?

B. Nature of Operations

1. What motor carrier category does your company fall in (i.e., LTL, TL, Common / Contract or some combination)?

2. Describe your company's operation approach.

3. Who are your customers, how many do you have in total?

4. Where are your customers located?

5. Describe the logistics patterns of your customers. Where do the services that you provide fit into their supply and distribution chain?

6. What are the performance standards that your company is subject to?

7. What are the penalties associated with non-performance?

8. How does your company target perspective customers?

9. How does your company market itself? What are your selling points?

10. What is your customer retention level?

11. Who from your company comes into contact with the customers (i.e., drivers, dispatchers, other company representatives)?

12. What operating or other productivity ratios does your company track?

13. Please provide an overview of your company's financial performance.

C. Driver Management

1. How are drivers compensated (e.g., per hour, load, etc.)?

2. What type of incentives does your company offer to drivers?

3. How would you describe your company's approach to quality of life issues with respect to drivers? How has this impacted driver retention?

4. **What type of interaction is their between drivers** and management? **Is** this considered to be important at your company?

5. What training does your company offer drivers (e.g., safety, etc.)? What is your company's philosophy about driver training?

D. Regulatory Compliance

1. Who is responsible for tracking drivers hours-of-service and other driver-related requirements?

2. Who is responsible for tracking information on individual vehicles (e.g., maintenance information, mileage, etc.)?

3. Who is responsible for obtaining vehicle / driver credentials?

4. What type of system(s) is being used to track this information (e.g., paper vs. data base)?

III. INDUSTRY SEGMENT DISCUSSION

1. How many carriers would you estimate are in your industry segment?

2. Break this down into local, regional, and national.

3. **How do** you think they vary with respect to range of operation?

4. How do you think they vary with respect to time sensitivity of shipments?

5. How do you think they vary with respect to route variability?

6. How do you think they vary with respect to fleet size (power units and trailers)?

7. In general, do you think most companies lease or own the equipment that they are operating?

a. How many drivers do most companies in your industry segment employ? Are most of the drivers company employees or contract drivers?

9. How profitable are most motor carriers in your industry segment?

IV. ROUTING/DISPATCHING DISCUSSION

A. "Walk Through" of **Routing and Dispatching Process**

1. What are the critical elements involved in the routing / dispatching process?

2. What type of information is being used for routing / dispatching?

3. How are unforeseen problems handled? For instance if a truck breaks down while moving a load.

4. Does the dispatcher maintain contact with drivers while they are in transit? If yes, what is the purpose of this communication?

5. If trucks are based at more than one location, is there more than one person responsible for routing and dispatching? If yes, are routing / dispatching activities coordinated?

6. How **much** slack time does the dispatcher usually have to work with?

7. What are the greatest day-to-day frustrations with respect to routing and dispatching?

V. CORPORATE MANAGEMENT SYSTEMS

A. Fleet Management

1. What hardware and software is currently being used to support fleet routing and dispatching? If more than one location is used for routing/dispatching, are the same systems being used?

2. When was the technology that you are currently using installed?

3. What are the strengths and weaknesses of the hardware/software?

4. What on-board systems are used for communication or record keeping?

5. When was this equipment installed?

6. What are the strengths and weaknesses of this equipment?

7. What systems were previously used? What prompted the decision to change/upgrade?

8. Has your company conducted cost-benefit analysis to determine the impact that this technology has had on fleet efficiency or operating cost savings?

9. If yes, please describe the analysis that was conducted. What were the units of measurement that were used (e.g., per truck, etc.)?

10. How does this technology relate to your ability to better serve customers?

11. Does the technology give your company a strategic advantage over your competitors?

B. Other Management Systems

1. Provide a brief overview of the other MIS that your company uses

2. What hardware/software is being used to support these systems?

3. Is the fleet Management hardware/software compatible with these other systems?

C. Relationship between Fleet Management Technology and other MIS

1. How does the fleet management system relate to other MIS?

2. What type of information is exchanged among systems or other company functional areas?

3. Describe your company's fleet budgeting **practices.** How does this process relate to other budgeting and accounting functions?

4. What are the limitations of the existing system?

VI. FUTURE ROUTING/DISPATCHING AND TECHNOLOGY

A. Anticipated Changes to Industry Environment Impacting Fleet Management

1. How will your customers needs change over the next decade?

2. Do you anticipate that your company will be providing the same services in the foreseeable future? If no, how do you see this changing?

3. If changes are expected how will this impact fleet management practices?

4. How will information needs change over the next few years?

5. What impact will technology advances have on your company and your competitors?

6. Do you see your company as an industry leader or follower with respect to the use of technology?

B. Anticipated Technology Advances

1. Do you anticipate any changes to the routing / dispatching system that is currently being utilized?

2. Anticipated changes to other corporate MIS which may impact fleet management?

C. Opportunities for Technology Applications

1. What equipment is available that you would like to be using now?

2. How would this benefit your operation?

3. What additional information would you like to have access to (e.g., congestion, road closures, etc.)?

BUS COMPANY INTERVIEW QUESTIONS

I. INTRODUCTION

Describe purpose of study and interview.

II. DEFINE FLEET OPERATION

A. Fleet Characteristics

1. How many buses does your company operate?
2. What type(s) of buses does your company operate?
3. How many of the buses does your company own vs. lease?
4. How many drivers does your company employ?
5. How many are company employees vs. contract or leased?
6. What is the union status of the drivers that operate your buses?
7. How many / what types of facilities does **your** company operate?
8. Where are these facilities located?
9. Provide an overview of your company's maintenance program (is this done in-house or out-sourced)? If maintenance is out-sourced, what are the advantages / disadvantages of this approach?
10. What is the criteria for replacing vehicles? What is the average age of the buses in your fleet?
11. If company leases buses, why have they chosen to do this? Have they conducted any cost-benefit analyses that justifies this approach?

B. Nature of Operations

1. Describe your company's operation approach.
2. Who are your customers?
3. Where are your customers located?
4. What are the performance standards that your company is subject to?

5. What are the penalties associated with non-performance?

6. How does your company target perspective customers?

7. How does your company market itself? What are your selling points?

8. What is your customer retention level?

9. What operating or other productivity ratios does your company track?

10. Please provide an overview of your company's financial performance.

C. Driver Management

1. How are drivers compensated (e.g., per hour, by trip, etc.)?

2. What type of incentives does your company offer to drivers?

3. How would you describe your company's approach to quality of life issues with respect to drivers? How has this impacted driver retention?

4. What type of interaction is their between drivers and management? Is this considered to be important at your company?

5. What training does your company offer drivers (e.g., safety, etc.)? What is your company's philosophy about driver training?

D. Regulatory Compliance

1. Who is responsible for tracking drivers hours-of-service and other driver-related requirements?

2. Who is responsible for tracking information on individual vehicles (e.g., maintenance information, mileage, etc.)?

3. Who is responsible for obtaining **vehicle/driver** credentials?

4. What type of system(s) is being used to track this information (e.g., paper vs. data base)?

III. INDUSTRY SEGMENT DISCUSSION

1. How many bus companies would you estimate are in your industry segment?

2. Break this down into local, regional, and national.

3. How do you think they vary with respect to range of operation?

4. How do you think they vary with respect to time sensitivity?

5. How do you think they vary with respect to route variability?

6. How do you think they vary with respect to fleet size?

7. In general, do you think most companies lease or own the equipment that they are operating?

8. How many drivers do most companies in your industry segment employ? Are most of the drivers company employees or contract drivers?

9. How profitable are most companies in your industry segment?

IV. ROUTING/DISPATCHING DISCUSSION

A. "Walk Through" of Routing and Dispatching Process

1. What are the critical elements involved in the routing/dispatching process?

2. What type of information is being used for routing/dispatching?

3. How are unforeseen problems handled? For instance, if a bus breaks down while in service?

4. Does the dispatcher maintain contact with drivers while they are in transit? If yes, what is the purpose of this communication?

5. If buses are based at more than one location, is there more than one person responsible for routing and dispatching?

6. How much slack time does the dispatcher usually have to work with?

7. What are the greatest day-to-day frustrations with respect to routing and dispatching?

V. CORPORATE MANAGEMENT SYSTEMS

A. Fleet Management

1. What hardware and software is currently being used to support fleet routing and dispatching? If more than one location is used for routing/dispatching, are the same systems being used?

2. When was the technology that you are currently using installed?

3. What are the strengths and weaknesses of the hardware/software?

4. What on-board systems are used for communication or record keeping?

5. When was this equipment installed?

6. What are the strengths and weaknesses of this equipment?

7. What systems were previously used? What prompted the decision to change/upgrade?

8. Has your company conducted cost-benefit analysis to determine the impact that this technology has had on fleet efficiency or operating cost savings?

9. If yes, please describe the analysis that was conducted. What were the units of measurement that were used (e.g., per bus, etc.)?

10. How does this technology relate to your ability to better serve customers?

11. Does the technology give your company a strategic advantage over your competitors?

B. Other Management Systems

1. Provide a brief overview of the other MIS that your company uses

2. What hardware/software is being used to support these systems?

3. Is the fleet Management hardware/software compatible with these other systems?

C. Relationship between Fleet Management Technology and other MIS

1. How does the fleet management system relate to other MIS?

2. What type of information is exchanged among systems or other company functional areas?

3. Describe your company's fleet budgeting practices. How does this process relate to other budgeting and accounting functions?

4. What are the limitations of the existing system?

VI. FUTURE ROUTING/DISPATCHING AND TECHNOLOGY

A. Anticipated Changes to Industry Environment Impacting Fleet Management

1. How will your customers needs change **over** the next decade?

2. Do you anticipate that your company will be providing the same services in the foreseeable future? If no, how do you see this changing?

3. If changes are expected how will this impact fleet management practices?

4. How will information needs change over the next few years?

5. What impact will technology advances have on your company and your competitors?

6. Do you see your company as an industry leader or follower with respect to the use of technology?

B. Anticipated Technology Advances

1. Do you anticipate any changes to the routing / dispatching system that is currently being utilized?

2. Anticipated changes to other corporate MIS which may impact fleet management?

C. Opportunities for Technology Applications

1. What equipment is available that you would like to be using now?

2. How would this benefit your operation?

3. What additional information would you like to have access to (e.g., congestion, road closures, etc.)?