Performance Metrics Used by Freight Transport Providers

Wayne D. Cottrell, Ph.D., P.E.
Civil Engineering Department
California State Polytechnic University, Pomona
Pomona, California 91768
wdcottrell@csupomona.edu

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California State Polytechnic University, Pomona

ABSTRACT

The newly-established National Cooperative Freight Research Program (NCFRP) has allocated $300,000 in funding to a project entitled "Performance Metrics for Freight Transportation" (NCFRP 03). The project is scheduled for completion in September 2009. According to the project's background discussion, "public and private decisions related to the freight industry should be based on a thorough analysis of the impacts of those decisions. These analyses are routinely made in the private sector but less commonly in the public sector. As the demand for freight movements outstrips the capacity of the nation's highway, rail, waterway, air, and port systems, the effects are felt as congestion, upward pressure on freight prices, and longer and less reliable transit times. These indicators of distress in the freight transportation system result in increased supply costs for manufacturers, higher import prices, and higher inventory levels. Ultimately, these costs add up to a higher cost of doing business for firms, a higher cost of living for consumers, and a less productive and competitive economy. Such indicators need to be quantified to be useful to decision makers as well as for public education on freight issues. Establishing consistent performance metrics for the freight system will be very helpful in conducting and comparing analyses of the freight system, particularly by identifying the critical data that are needed to assess system performance." This report investigates freight transportation performance metrics from one perspective; that is, that of the freight transport providers. In combining the findings of this study with those of the NCFRP study, and other efforts, it may be possible to develop a basis for national and international goods movement performance measurement. One objective is for the measures to be used to better understand freight transport issues, and to relieve some of the industry's "distress," while facilitating the economic growth that is facilitated by an efficient goods movement system.

EXECUTIVE SUMMARY

A total of 19 billion tons of freight, having a total value of $13 trillion, were moved in the U.S. in 2002. The dominant freight transport modes, in terms of ton-mileage, were trucks, railroads, pipelines, and ships. Aviation had the fifth greatest modal contribution. Trucks accounted for 70% of the value of all shipments in the U.S. Railroads dominated the long-distance (greater than 500 miles) freight market. Aviation dominated the international shipment of high-valued goods. Freight transportation's leading providers were Schneider National Carriers and United Parcel Service in the trucking industry, Union Pacific in the railroad industry, Ingram Barge Company in waterborne shipping, FedEx Express in air freight, El Paso Natural Gas in natural gas pipeline throughput, and Enbridge Energy in oil pipeline throughput. The national freight infrastructure was served by extensive highway, railroad, waterway, and pipeline networks, as well as large port and airport systems. The backbone of the highway system is the National Network, an extensive truck system that is essentially equivalent to the 46,871-mile Interstate System. The railroad network encompasses 141,698 miles, of which 95,663 miles are owned by the Class I railroads. The waterborne shipping industry is supported by the nation's 300-plus ports, the largest of which serve ocean-going vessels in the Gulf of Mexico (South Louisiana), Pacific Ocean (Los Angeles-Long Beach), and Atlantic Ocean (New York City). The 9,300-mile inland commercial waterways system stretches into the interior of the central U.S.; locks, dams and levees are in need of upgrading to sustain the viability of this aspect of the maritime industry. The (mostly) underground flow of goods is supported by 1,414,200 miles of natural gas pipelines, and 131,353 miles of oil pipelines. There are over 5,200 public-use airports in the U.S., many of which are equipped to accommodate air freight. John F.

Kennedy International Airport is the largest air freight gateway in the U.S., and is the busiest freight terminal (the Ports of Los Angeles and Long Beach are the second busiest). The "smallest" freight sector, local messenger and delivery services, involves bicycles, motorcycles, and other small delivery vehicles – generally in the core areas of large cities. The industry earned a not-insignificant $7.9 billion in 2006.

Performance measurement in the freight transport industry has attracted two realms of interest: that of the public sector, and that of the providers. The public sector is keenly interested in measures that justify policy decisions, such as asset productivity, total shipments, total flow, and so forth. The public sector is also interested in measures that indicate how well regulations and standards are being met. These would include environmental and safety measures, such as total fleet emissions of criteria pollutants, employee injuries, and fatalities. The providers have an interest in economic measures, such as aspects of financial performance, along with equipment, load, haul, employee, and customer service measures. The two realms cross over in only a few areas; for example, productivity, load and haul are all related, are of interest in the public and private sectors. Otherwise, there are significant distinctions. For example, while the public sector is interested in fatalities, injuries and spills, the freight providers seem to be more interested in the *effects* of these incidents on insurance costs, tort and liability.

There is little uniformity in performance measurement in freight transportation, particularly across the five modes. Some measures, by necessity, are pertinent to only one or two modes, such as "barrels per day" in the oil pipeline industry, and "carloads originated" in the railroad industry. Also, there is little agreement on the "best" or "most critical" performance measures, even among individual providers. One motor carrier, for example, was using about 300 measures to represent different aspects of its operations and resources. For many of the providers, a large number of measures are financial, with multiple versions of revenue, expenses, and revenue-related ratios, along with the before and after effects of taxes, interest, depreciation, insurance and other costs. Despite the lack of uniformity and consensus, six measures seem to be represented in all five of the freight transport modes:

- Average length of haul
- Operating ratio
- Revenue per ton-mile
- Tonnage (total, all loads)
- Ton-miles or barrel-miles
- Terminal dwell time or empty miles factor

The average length of haul is a measure of productivity that is useful for separating short-distance from long-distance shipments. Increases in this measure may be indicative of expansion, and possibly service optimization. The operating ratio is one of the simplest measures of financial performance. The operating ratio is simply the total expenses divided by the total revenue. Revenue per ton-mile, tonnage and ton-miles (or barrel-miles) are all load- and haul-related measures. Ton-miles are used as a key benchmark of freight movement activity in private industry and government. The four main freight modes – trucks, railroads, ships and pipelines – are surprisingly well balanced in the U.S. in terms of their proportions of total ton-mileage. It is possible that a national freight transportation plan or system, incorporating all modes, would aim for a load-haul balance. (It is possible that such a system might be supported by a well-developed performance measurement system). Terminal dwell time and the empty miles factor are measures of "non-productivity." Freight transport providers probably aim to reduce these measures, as a means of improving efficiency and productivity.

The literature on freight transportation and logistics is extensive. Many of the authors suggest how certain aspects of goods movement could be optimized. Some of the authors also recommend measures that could serve as optimization criteria. Optimization is often associated with idealized spatial distributions of activity, which may be difficult to apply in practice. Similarly, many of the recommended measures are theoretically sound, but are difficult to compute or replicate with existing data collection strategies. It is anticipated that the NCFRP Project 03 will be a major step forward in the understanding of freight transport performance measurement, and data collection.

INDUSTRY OVERVIEW

According to *Freight in America* (BTS 2006) 19 billion tons of freight, having a value of $13 trillion, were moved within the U.S. in 2002. The cumulative weight and distance moved was 4.4 trillion ton-miles. On a typical day, 53 million tons of goods were being moved about 12 billion ton-miles within the U.S. transport network (68 tons and 15,310 ton-miles per capita). In terms of ton-mileage, the dominant freight transport modes were trucks (34%), railroads (31%), pipelines (16%), and ships (11%). The remaining 8% were carried by aircraft and other modes. Trucks were the dominant mode for shipment distances of less than 500 miles, and rail was dominant over longer distances. California led the nation in total commodity flows, with 11% of the total value. The Los Angeles-Long Beach-Riverside metropolitan area led the nation, compared to other metro areas, in commodity flows and weight.

The freight transport industry is complex and intermodal, such that more than one mode may be used to transport a good during its origin-destination journey. Truck plus rail, truck plus water, and rail plus water are common multimodal combinations. Overall, trucking is the most frequently used mode for goods transport, accounting for 70% of the value and 60% of the weight of all U.S. shipments in 2002. On the fringes of the freight transport provider industry are the intermediaries, or "freight forwarders," who act as brokers between shippers and carriers. The freight forwarders can generally be categorized as either 3PL or 4PL. Third-party logistics service providers (3PL) offer a number of functions, including order processing, warehousing, tracking and payments. Fourth-party logistics service providers (4PL) are multifaceted organizations that may link several 3PL companies, while managing worldwide trading systems.

As would be expected, performance measures and concerns vary according to the freight transport market sector. There can also be variation within the given mode, according to the magnitude and scale of operations. The following sections discuss the freight transport providers within the various freight modes.

FREIGHT TRANSPORT PROVIDERS

Trucking

The trucking industry can be classified into three types of carriers: parcel, full truckload (FTL), and less-than-truckload (LTL). FTL carriers typically carry fully or partially-loaded containers from a shipper to a single destination. The freight is not handled en route, since all contents are bound for the same point. LTL carriers collect freight from different shippers, consolidating the goods into containers for line-haul to a terminal. The freight may be further sorted or consolidated at the terminal for continued hauling. LTL shipments typically weigh between 100 and 10,000 lb. Some FTL carriers have a 10,000 lb minimum shipment. Parcel carriers typically carry shipments weighing no more than 150 lb, although some carriers were starting to move heavier packages.

Commercial vehicle carriers are commonly classified according to "small" and "large." Small carriers have annual revenue of $30 million or less, while large carriers have annual revenue of $30 million or more. The Bureau of Transportation Statistics uses a *three*-part classification scheme, in which Class I carriers have an annual operating revenue of more than $10 million, Class II carriers have annual revenue between $3 and $10 million, and Class III carriers have annual revenue of less than $3 million. Just over one million carriers were registered with the Federal Motor Carrier Safety Administration as of 2006. The nation's "top 100" motor carriers, in 2004, are listed in Table A1 (Appendix). Major FTL carriers included Schneider National Carriers ($3.20 billion in revenue in 2004), Swift Transportation Company ($2.83 billion), J.B. Hunt Transport ($2.79 billion), Werner Enterprises ($1.68 billion), and Landstar Carrier Group ($1.45 billion). Major LTL carriers included United Parcel Service ($36.58 billion in revenue in 2004), Federal Express Express ($19.49 billion), DHL Worldwide Express ($8.57 billion), Federal Express Ground ($4.68 billion), and Federal Express Freight ($3.22 billion). None of

these providers was headquartered in California, although all had satellite offices nationwide. The largest FTL carriers headquartered in California were Pacer International ($406.0 million) and Beneto Bulk Transport ($73.4 million). The largest California-based LTL carriers were GI Trucking ($215.5 million) and Dependable Highway Express ($79.5 million). The industry is under a constant state of flux, with mergers, acquisitions, and market-oriented modifications.

Major parcel carriers had traditionally included United Parcel Service (UPS) and Federal Express (FedEx). Both carriers "upgraded" to LTL status, however, with UPS' purchase of Overnite Corporation in 2005, and FedEx' acquisition of Viking Freight (in 1998) and American Freightways (in 2001). The third-largest parcel carrier, DHL, is also classified as LTL. The Parcel Shippers Association (www.parcelshippers.org) membership list includes 59 companies.

Combination trucks, which perform the bulk of truck shipments, are served by the National Network (NN). The NN is essentially identical to the Interstate System. In most States, additional truck routes facilitate penetration into areas not served by the Interstate System. In California, for example, Terminal Access, Service Access, and California Legal routes enable large, legally-sized trucks to access terminals, authorized service routes, and non-Interstate highways. Combination trucks traveled 143.66 billion miles on the National Network and other truck routes in 2005 (BTS 2007).

Railroads

As of 2002, there were 552 railroad carriers in the U.S., operating over 141,698 miles of track, and earning $36.92 billion in revenue. There were four categories of railroad: Class I, Regional, Line-haul, and Switching & Terminal. Class I railroads had revenue of at least $347 million in 2006. The seven Class I railroads earned 92% of the U.S.' freight railroad revenue in 2002. The Class I railroads were:

- Burlington Northern & Santa Fe
- CSX Transportation
- Grand Trunk Corporation (Canadian National, Grand Trunk Western, Illinois Central, Wisconsin Central)
- Kansas City Southern
- Norfolk Southern
- Soo Line
- Union Pacific

Regional railroads covered at least 350 route miles and had annual revenue between $40 million and the Class I threshold. There were 31 Regional railroads in 2002. Line-haul railroads generally provide point-to-point service within a single State, operating over fewer than 350 miles and with annual revenue less than $40 million. Switching & Terminal railroads perform pickup and delivery services for one or more connecting line-haul carriers. There were about 300 Line-haul and 200 Switching & Terminal railroads in 2002. Class I railroads dominate the industry in terms of freight revenue. Some 40,000 miles of track are owned and used by *non*-Class I railroads, however.

Maritime

Waterborne transportation was involved in the movement of about 9% of freight in the U.S. in 2004. This amounted to 2.4 billion tons of goods in 2003. Container ports handled over 65,000 TEUs (20-foot equivalent container units) per day in 2004. Most container units were involved in a form of intermodal exchange, either between ship and rail or ship and truck. Freight transport providers within the maritime sector can be divided into two major groups: ports, providing the infrastructure for freight movement and exchange, and the marine vessels that actually move the freight. Maritime differs from the other modes in that the freight infrastructure (ports) may be owned by government or independent authorities (in trucking, the infrastructure is generally government-owned, while in railroads, the infrastructure is private-

Figure 1. Class I Railroads (*BNSF = Burlington Northern & Santa Fe; CN/GTW = Canadian National/ Grand Trunk Western; CP/SOO = Canadian Pacific/ Soo Line; CSX = CSX Transportation; FXE = Ferrocarril Mexicano; KCS/KCSM = Kansas City Southern; NS = Norfolk Southern; UP = Union Pacific*). SOURCE = American Association of Railroads.

ly-owned). The port authorities are separate from the companies that operate the marine vessels. There are over 300 ports in the U.S. Table 1 lists the top 20 ports in the U.S. in 2005, by total annual shipment weight, and by total number of 20-foot equivalents (i.e., number of container equivalents). Many of the busiest ports by total weight of shipments were along the Gulf Coast, where the primary goods were oil and petroleum products. The busiest container ports were at Los Angeles and Long Beach, with Oakland the fourth-busiest. California has 12 ports of various capacities levels of activities, three of which are among the five busiest ports in the U.S.

The U.S. Army Corps of Engineers maintains a 200+ page list of marine vessel companies (*WTLUS 2006*), thereby suggesting the size and number of participants in the industry. These companies operate barges, cargo carriers, container ships, pushboats, tugboats, and other types of freight vessels. The five largest marine vessel companies in 2006, in terms of the number of vessels operated, included Ingram Barge Company (4,210 vessels; based in Nashville, Tennessee), American Commercial Lines (3,266; Jeffersonville, Missouri), American River Transportation Company (2,267; Ama, Louisiana), AEP Memco (1,770; Chesterfield, Missouri), and Kirby Inland Marine (1,090; Houston, Texas).

Pipelines

Pipelines in the U.S. carry energy commodities, including oil and petroleum products, and natural gas. A total of 868 billion ton-miles of oil and gas were moved by pipeline in the U.S. in 2003. The oil and gas pipeline networks are each divided into three functions: gathering, transportation or transmission, and dis-

Table 1. Top 20 U.S. Water Ports by Shipment Weight & Container TEUs: 2005

Port by shipment weight	Short tons (millions)	Port by container TEUs	Full TEUs (thousands)
South Louisiana, LA	212.2	Long Beach, CA	5,200
Houston, TX	211.7	Los Angeles, CA	4,375
New York, NY and NJ	152.1	New York, NY	3,581
Huntington-Tristate, WV-OH-PA	83.9	Oakland, CA	1,561
Long Beach, CA	79.9	Tacoma, WA	1,545
Beaumont, TX	78.9	Charleston, SC	1,514
Corpus Christi, TX	77.6	Savannah, GA	1,486
New Orleans, LA	65.9	Seattle, WA	1,443
Baton Rouge, LA	59.3	Norfolk, VA	1,436
Texas City, TX	57.8	Houston, TX	1,290
Mobile, AL	57.7	Honolulu, HI	856
Los Angeles, CA	54.9	Miami, FL	778
Lake Charles, LA	52.7	San Juan, PR	726
Tampa, FL	49.2	Port Everglades, FL	591
Plaquemines, LA, Port of	47.9	Jacksonville, FL	582
Duluth-Superior, MN and WI	44.7	Baltimore, MD	487
Valdez, AK	44.4	Anchorage, AK	293
Baltimore, MD	44.1	New Orleans, LA	177
Pittsburgh, PA	43.6	Wilmington, DE	162
Philadelphia, PA	39.4	Boston, MA	160
Total, top 20	**1,558**		**28,241**
Total, all ports	**2,528**		**30,059**

NOTE: TEU = 20-foot equivalent container. (BTS, *Pocket Guide to Transportation*, 2008).

tribution. The transmission lines are the heart of these networks. According to a 2002 survey, 51 U.S. and 10 Canadian transmission lines carried 85% of the natural gas in North America. *Pipeline & Gas Journal* regularly ranks pipelines according to various aspects of performance. A summary of their year 2006 rankings leaders is provided in Table 2. The National Natural Gas Pipeline Network, as of 2000, is shown in Figure 1. As shown, there are heavy concentrations of pipelines in the Gulf Coast and Louisiana, western Oklahoma, and western Texas. Major gas lines extend into all of the continental United States.

Table 2. Leading Gas & Oil Pipeline Companies (2006)

Aspect of Performance	Company	Amount
Gas piping	Southern California Gas	95,603 miles
Gas sold	Public Service Electric & Gas	2,043,083 MMcf
Gas throughput	El Paso Natural Gas	5,641,319,000 Dth/y
Gas operating revenues	Duke Energy Field Services	$12,335,000,000
Liquids (oil) piping	Magellan Pipeline	8,583 miles
Crude oil deliveries	Enbridge Energy	553,528,000 Bbl
Liquids (oil) operating revenues	Colonial Pipeline	$764,100,000

SOURCE: *Pipeline & Gas Journal*, Nov. 2007.
NOTE: MMcf = millions of cubic feet; Bbl = barrels; Dth/y = ?

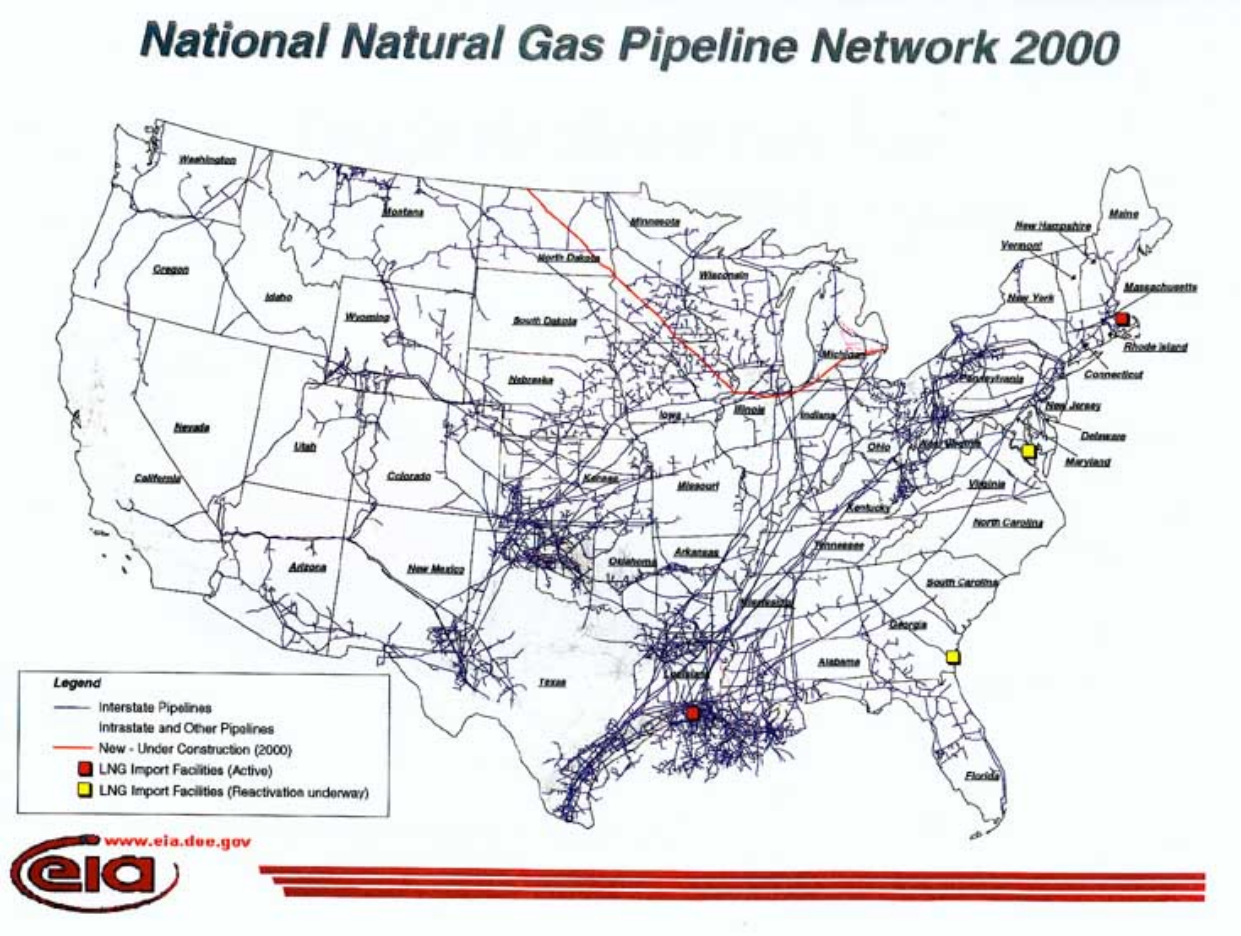


Figure 1. National Natural Gas Pipeline Network, 2000

The major trunklines of the U.S.' crude oil pipeline network are shown in Figure 2. A large concentration of pipelines emanates from the ports adjacent the offshore drilling platforms along the Gulf Coast. Trunklines extend from the Texas coast to Illinois, Ohio and Indiana. One trunkline runs north-south through central California, extending from Los Angeles to the Bay Area. The network extends into Canada to incorporate several trans-border pipelines. The network of refined (petroleum) products pipelines is shown in Figure 3. This network is separate from and in addition to the crude oil pipelines. A heavy concentration of the refined products pipelines is in the midwestern U.S., particularly Illinois, Indiana, Missouri, Iowa, Kansas, and a few other States.

Aviation

Aircraft were used to transport about 4% of the value and 1% of the tonnage of goods in the U.S. in 2002. A total of 37 billion ton-miles of goods were moved by aircraft in the U.S. in 2004. Despite the large value, aviation is a "distant fifth" to the four primary freight modes – trucks, railroads, maritime and pipelines – in terms of goods movement in the U.S. Aircraft do, however, carry over 25% of the value of all U.S.-international merchandise. Similarly to maritime, aviation's role in freight transport can be separated into two groups: airports and air carriers. Also, as with maritime, the airport and air carrier owners and operators are different.

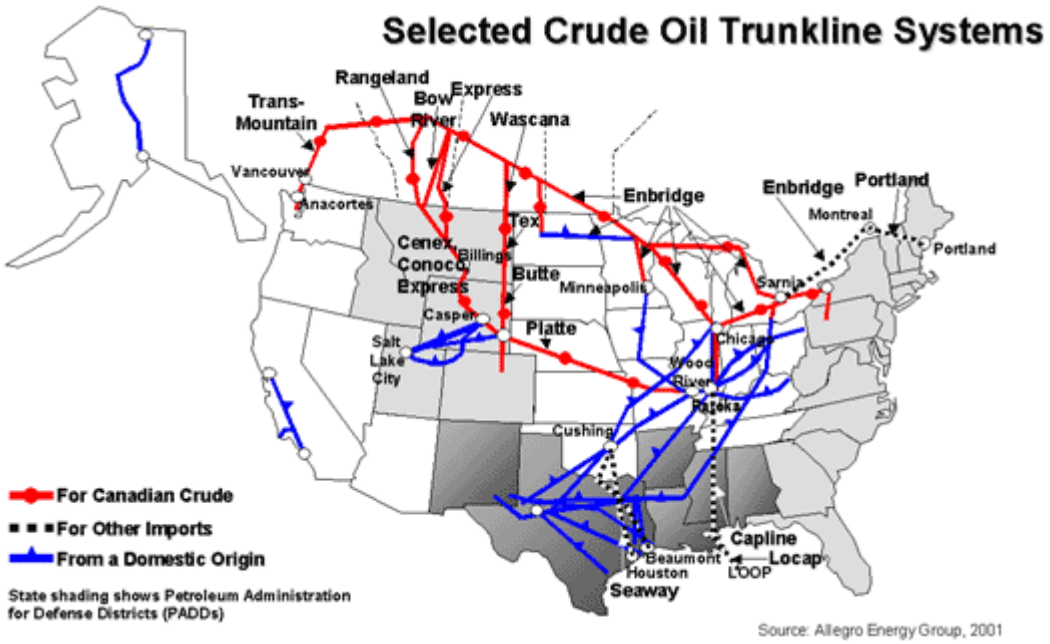


Figure 2. Crude Oil Pipelines Network – Major Trunklines (2001)

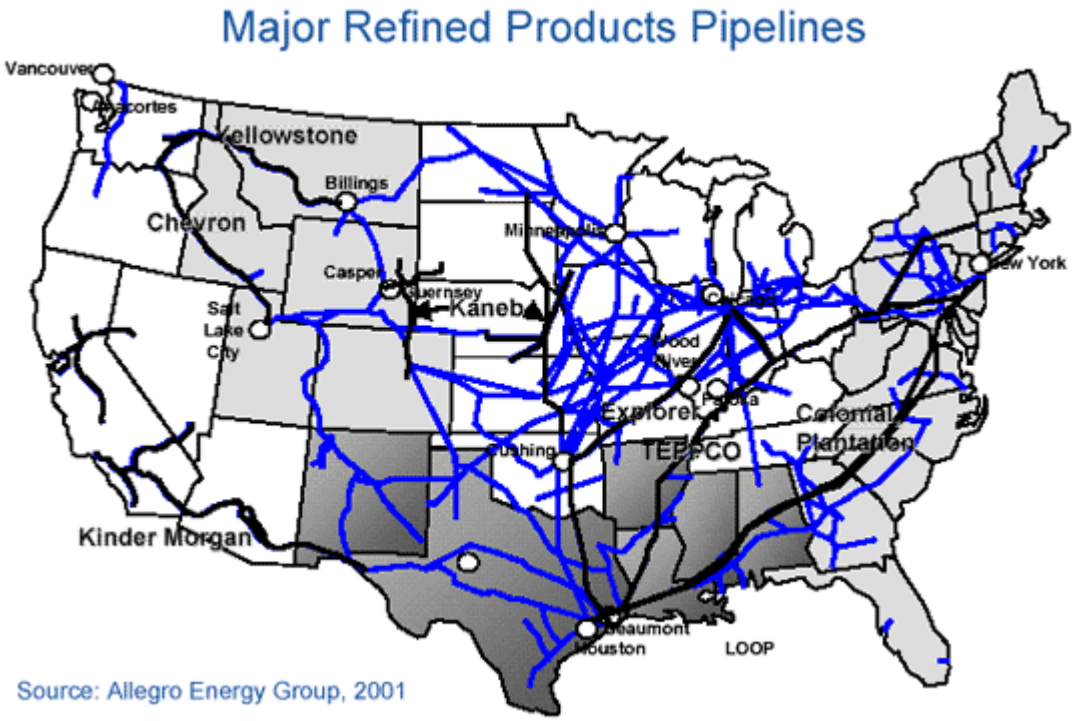
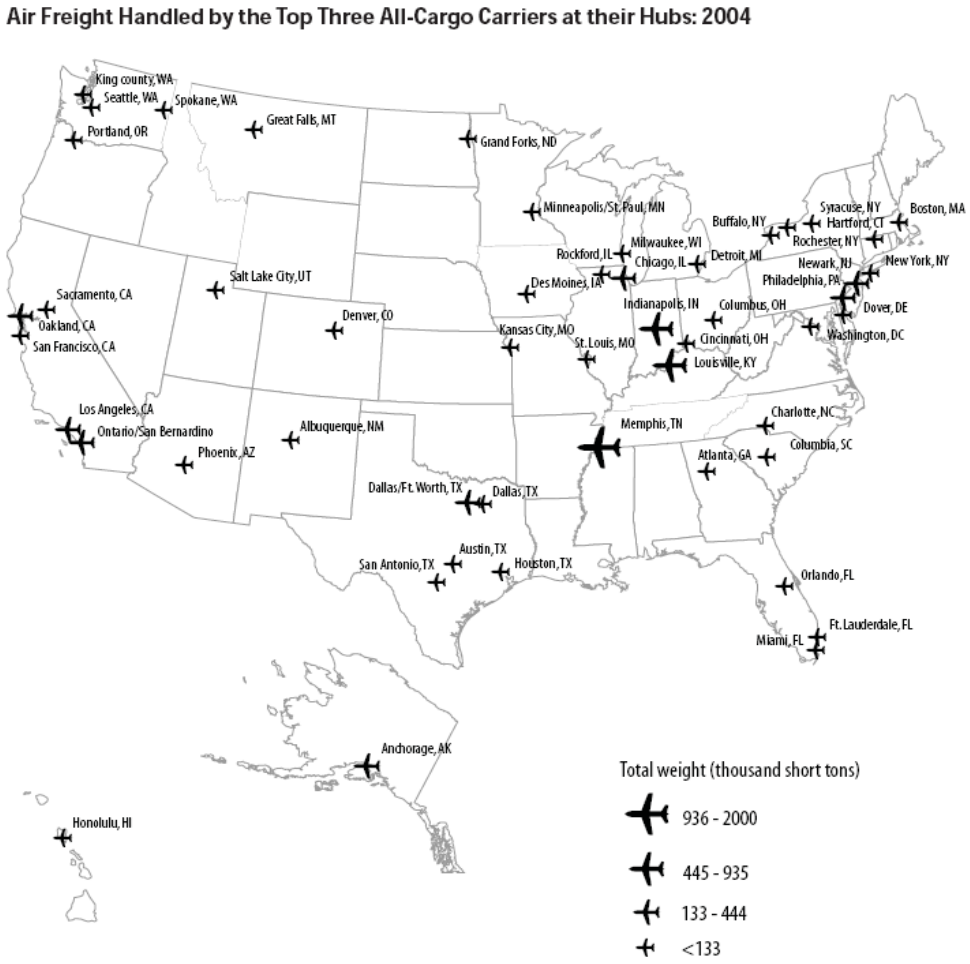


Figure 3. Major Refined Products Pipelines (2001)

Despite aviation's secondary role in freight movement in the U.S., an airport – John F. Kennedy International (JFK) in New York City – is the U.S.' busiest freight gateway. In 2004, more U.S.-international freight revenue ($125.3 billion) moved through JFK than through either the Port of Los Angeles or the Port of Long Beach (which were the second and third busiest freight gateways). Other than JFK, Los Angeles International Airport ($68.7 billion), O'Hare International Airport in Chicago

($65.4 billion), San Francisco International Airport ($54.6 billion), and Dallas-Fort Worth Airport ($31.2 billion) were also busy air freight gateways. Miami International Airport claimed leadership in international freight *tonnage* (2.1 million) in 2007. Domestic air freight was dominated by Federal Express, United Parcel Service and DHL. Figure 4 shows the airports that were most used by these three parcel carriers. Memphis International Airport had the most domestic air freight activity in 2004, followed by Louisville International Airport and Indianapolis International Airport.



NOTE: This map represents freight handled by United Parcel Service, Fedex, and DHL at their airport hubs.

Figure 4. Major Air Parcel Hubs (2004)

Forster and Regan (2001) characterized the air freight industry as two organizational structures: integrators, who own all assets of production from shipper to consignee, and non-integrators, who forward, carry and deliver cargo. As of 2000, there were some 25,000 forwarders and 700 air cargo carriers worldwide, with 1,500 forwarders and 100 air carriers in the U.S. Leading integrators were FedEx and United Parcel Service (UPS), while airlines such as Lufthansa and United were forwarders. The most active air freight carriers (domestic) in the U.S. in 2004 were FedEx Express, which moved 8.984 million tonne-km of freight, followed by UPS (4.260 million tonne-km), Northwest Airlines (0.949 million tonne-km), China Southern (0.860 million tonne-km), and American Airlines (0.576 million tonne-km). Notice that the ranking blends integrators and non-integrators.

Other Modes

In addition to the primary freight modes of trucking, railroads, maritime and pipelines, as well as aviation, goods are also moved in the U.S. by bicycle couriers, foot messengers, cars, and motorcycles. Limited statistics are available on these "other modes." IBIS World reported that local delivery and messenger services were a $7.9 billion industry in 2007, with about 220,000 employees and about 177,000 business establishments. A total of 73.4% of the revenue were earned by pickup, van, and small car delivery services. The remaining 26.6% of the revenue were earned by bicycle and foot messengers, and motorcycle, moped, and small-box truck delivery services. Although this sector is a vital component of the freight transport industry, particularly in the central business districts of cities, the revenue generated by local delivery and messenger services represents less than 0.1% of the total U.S. freight transport industry revenue.

Yet another category is the "virtual" shipping of documents by e-mail, fax and the internet. These electronic modes have not yet been incorporated into the scope of transportation engineering. That is, freight transportation statistics do not reflect "electronic" goods, although the *impact* of these virtual modes of transport on the traditional modes has been discussed. De Jong et al. (2006), for example, predicted that freight transport would increase in the so-called "e-economy." Similarly, Smith et al. (2002) predicted rapid growth in "e-business," and the potential for freight transport to aid this growth. Although the indication is that freight transport activity will increase in the e-economy, the impact on *local* messengers and couriers has not been identified.

Summary

The diversity of the U.S. freight transportation industry is evident in the data shown in Table 3. Air, road, water, rail and pipeline modes are used to move goods. Trucking dominates the amount of freight revenue generated in the U.S., but railroads are competitive with trucks in terms of total shipment weight. Aviation makes only a minor contribution to domestic freight, but is a major player in international shipments. Performance measures and standards are diverse, to fit the needs of the various modes and categories within the modes, as well as the modal providers. A few performance measures are common to all modes, such as revenue and ton-mileage. A full understanding of the measures, measurement needs, and standards of freight transport providers requires an investigation of the separate modes and, to a certain extent, the providers themselves. The industry is competitive, primarily as a consequence of governmental deregulation of the various modes. It is a challenge to "tap into" the data and statistics of the industry given the proprietary aspects. The Surface Transportation Board and the U.S. Department of Transportation require that certain statistics be reported, however, enabling an investigation of this information. This study focused on learning from the readily-available data. A more extensive – and expensive – investigation would involve industrial contacts, and possibly a survey, to acquire a fuller understanding of freight transport provider performance. The following sections of this report feature a review of the literature on freight transport performance measures, followed by a discussion of performance within each of the freight modes.

Table 3. Overview of U.S. Freight Transportation Industry

Mode	Category(s)	Leading Provider (2002-2006)	Industry-Wide	
			Revenue[1]	Ton-Miles[2]
Aviation	Air carriers Airports	FedEx Express JFK (international) Memphis (domestic)	$265.0	16,451
City streets	Local messengers	NA	$7.9	--
Highways	Trucks	Schneider National Carriers (FTL) United Parcel Service (LTL)	$6,235.0	1,314,616
Maritime	Marine vessels Ports	Ingram Barge Company South Louisiana (by weight) Long Beach (by TEUs)	$89.3	621,170
Pipelines	Pipelines	El Paso Natural Gas (throughput) Duke Energy Field (gas revenue) Enbridge Energy (oil throughput) Colonial Pipeline (oil revenue)	$149.2	938,013
Railroads	Railroads	Union Pacific	$310.9	1,684,461
TOTAL			$8,397.2	4,574,711

[1] Modal totals, in billions of dollars (2002). Air revenue includes truck connections.
[2] Modal totals, in millions (2004).
SOURCE: BTS (2007).

FREIGHT PERFORMANCE MEASURES: LITERATURE REVIEW

Morash (2000) explained that there are five categories of freight performance measurement: asset management, cost, customer service, productivity, and quality. Further, there are four categories of freight stakeholders: the freight infrastructure provider (e.g., transportation agency, port), the producer of goods (i.e., manufacturer), the shipper, and the customer. Each category of measurement is subject to a different interpretation by each of the stakeholder groups; also, some of the categories may not be applicable to certain stakeholder groups. Thus, it is possible to develop a three-dimensional matrix with up to 20 cells, each containing a set of performance measures related to the given measurement category and stakeholder group. This research concentrates on "freight transport providers;" i.e., the shippers, and the freight infrastructure providers. Hence, the scope of the investigation is limited to a proportion of the potentially 20 cells.

Overview of Literature Findings

The literature on freight performance measurement has become more active in recent years than in years past. For example, a review of several databases revealed as many articles published since 2000 as were published in previous years. The heightened activity is because, in part, of an increasing reliance of economies on the reliable movement of goods. From the pre-2000 references, Boisjoly (1979) reported on 20 motor carrier performance measures, two of which were given special attention: revenue per ton-mile and the ratio of operating expenses to revenue (the operating ratio). Miller (1990) concentrated on customer service, using five measures: request date, first acknowledgement, published interval, last acknowledgement, and last positive acknowledgement. Each measure was associated with a shipping timeline extending from pickup to dropoff, and final acknowledgement of a shipment's receipt. Mentzer and Konrad (1991) listed a collection of efficiency and effectiveness performance measures in five categories: transportation, warehousing, inventory control, order processing, and logistics administration. Their measures are listed in Table 4. One of the authors' arguments was that measures needed to address

both efficiency and effectiveness, rather than one or the other, partially because of the difficulty in defining "100% efficiency" or "100% effectiveness."

Ferreira and Sugut (1992) identified three major performance measures for road-rail container transfer facilities: customer service, operational efficiency, and terminal productivity. The authors noted that an underlying constraint in a performance measure system would be the total capital and operating costs (i.e., budget). Australia's Bureau of Industry Economics (1992) suggested two types of indicators for the road freight industry: customer service and operational efficiency. Measures within each category were obtained from a survey of (mostly) Australian freight transport providers. The report identified four key customer service measures: on-time pickup (% of pickups), on-time delivery (% of deliveries), loss and damage rate, and proportion of claims paid. Six operational efficiency measures emerged as the most common among the providers surveyed:

- total kilometers per vehicle per year
- total ton-kilometers per vehicle per year
- kilometers traveled empty as a proportion of total kilometers traveled
- average actual load as a proportion of full load capacity
- number of kilometers per driver per year
- fuel usage by vehicle type

Stewart (1995) discussed four "keys" to unlocking "supply chain excellence:" delivery performance, flexibility and responsiveness, logistics cost, and asset management. His suggested performance metrics were as follows:

- Delivery performance: % of orders fulfilled on or before the customer requested date; % of orders fulfilled on or before the original schedule or committed date.
- Flexibility and responsiveness: supply chain response time (a sum of four components, including communications to end-product and feeder plants, product sourcing, and lead time).
- Logistics cost: order management cost; materials acquisition cost; inventory carrying cost; supply chain finance, planning and management information systems (MIS) cost.
- Asset management: cash-to-cycle time (= total inventory days-of-supply + days-sales-outstanding – average-payment-period to suppliers).

Appfel, et al. (1996) described a methodology for determining freight terminal capacity. Two types of freight terminals were identified: flow processing components and stock holding components. Flow processors did not store cargo, and were involved only in transferring goods. Two measures were developed for the two terminal types:

- Dynamic capacity of flow (tons per year) = effective transfer rate (tons per day) * effective working time (days per year)
- Dynamic capacity of stock component (tons per year) = effective static capacity (tons) * effective turnovers (per year)

The above measures could be adapted by freight transport providers to their inventory control concerns. Lawrence, et al. (1997) categorized a broad spectrum of "infrastructure industries" into four areas of performance: price, service, labor productivity, and capital productivity. All freight modes were considered, as well as several public utilities. The measures developed, all of which were supported with industry data, were:

- Price: average revenue per net ton-kilometer; waterfront charges per twenty-foot equivalent container (TEU); waterfront charges per ton; standard dry bulk vessel operating costs; long-haul cents per ton-kilometer.

Table 4. Freight Logistics Performance Measures (Mentzer and Konrad, 1991)

Transportation	Warehousing	Inventory Control	Order Processing	Logistics Admin
Vehicles loaded or unloaded per labor hour	Equivalent vehicles loaded or unloaded per labor hour	Activity per labor hour	Activity per labor hour	Activity per labor hour
Weight loaded or unloaded per labor hour	Weight loaded or unloaded per labor hour	Cost savings per labor hour	Activity per facility per day	Activity cost
Miles driven	Lines, cases, orders or units per labor hour		Total order activity	Activity cost per unit
Driving hours	Dollar value per labor hour	Accuracy		
Miles per driving hour	Weight unloaded per dock door per day			
Labor hours used	Labor hours		Labor hours expended	
Transit hours per trip	Equivalent vehicles unloaded per dock door per day			
Cost	Cost	Cost	Cost	
Total cost per unit	Weight, orders, lines or units throughput per labor hour	Total cost per unit	Total cost per unit	
Equivalent cost of outside substitute	Weight, units or pallets throughput per total warehouse cost			
Downtime	Downtime	Equipment downtime	Downtime	Equipment downtime
Equipment hours	Weight, units or pallets throughput per hour	Equipment hours	Equipment hours	
Units per hour	Lines, units or orders per square foot	Units per hour	Units per hour	Units per hour
Fuel use per mile Fuel use per tonmile Fuel use per stop	Units, weight, lines, orders or dollars throughput per square foot			
Miles driven per gallon	Transactions processed on time			
Transit time	Replenishment cycle time			

- Service: claims for loss or damage in cents per $100 revenue; hours to move 600 boxes; percentage of late deliveries; percentage lost and damaged.
- Labor productivity: millions of net ton-kilometers per employee; TEUs per employee; thousands of tons per employee; manning level of small dry bulk vessels.
- Capital productivity: millions of net ton-kilometers per railcar; millions of net ton-kilometers per locomotive; throughput/capacity (%); crane rate in moves per hour; thousands of tons per kilometer per year.

Some of the measures were extracted from the BIE (1992) report, discussed earlier. Stainer (1997) emphasized productivity measures as being, perhaps, the most meaningful indicators of logistics performance. He noted that productivity could be divided into three types, each with a different measurement scope:

- Partial productivity: ratio of total output to a single input, such as labor, materials or capital.
- Total factor or value-added productivity: total sales less bought-in goods, materials and services.
- Total productivity: ratio of total output to total input.

Duma (1999) argued that the ton-kilometer, although widely used, was not a powerful enough measure to differentiate between freight transport activities, or to characterize the importance of transport modes. Although the author did not recommend any measures, the following were suggested for consideration:

- Weight of transported goods
- Transport distance
- Transport tariff revenue
- Transported units
- Number of vehicles
- Capacity measurements (no examples given)
- Operation time/haulage time
- Fuel & energy consumption
- Utilization/crowd indexes (no definition provided)
- Artificial indexes (to be defined by the user)

A Transportation Research Board conference (TRB, 2001) brought together Federal Highway Administration (FHWA) and State Department of Transportation officials to "hash" out several performance measurement issues, including freight movement. Although no definitive measures were identified or recommended, a heavy emphasis was placed on the data needed to compute key measures. One conclusion is that any performance metric, for it to be useful, must be tractable. Also, a list of feasible metrics may represent the constraints of data availability. Gunasekeran, et al. (2001) identified multiple measures in four supply chain categories: plan, source, make-assemble, and delivery-customer. Their proposed measures are listed in Table 5.

Table 5. Supply Chain Performance Metrics (Gunasekeran, et al., 2001)

Plan	**Source**	**Make-Assemble**	**Delivery-Customer**
Total order cycle time Customer order path	Level of supply chain partnership	Capacity utilization Effectiveness of scheduling techniques Productivity of human resources Actual vs. planned throughput Inventory levels Manufacturing cost	Delivery-to-request date Delivery-to-commit date Order fill lead time Percentage of goods in transit Number of faultless notes invoiced Flexibility of delivery systems Logistics distribution cost Customer query time Customer perception of service Total logistics cost Total cash flow time Total inventory cost

Lai, et al. (2002) separated the supply chain process into two segments: "customer facing" (i.e., customer service) and "internal facing" (i.e., operations). The primary concerns of customer facing were identified as reliability, flexibility and responsiveness, while the main concerns of internal facing were costs and assets. Their suggested performance measures were:

- Customer facing: delivery performance, order fulfillment performance, and perfect order fulfillment (reliability); supply chain response time and production flexibility (flexibility and responsiveness).
- Internal facing: total logistics management costs, value-added productivity, and return processing cost (costs); cash-to-cash cycle time, inventory days of supply, and asset turns (assets).

Lai, et al. (2004) extended this discussion by adding measures related to shippers' needs, as well as the needs of consignees. Holguin-Veras, et al. (2004) developed an experimental economics approach to urban goods modeling. To evaluate their model, the following measures were used: number of tours required to meet freight needs, total profits, total number of stops, profits per tour-hour, profit per tour per unit freight, and profit per tour-hour per unit freight. A "tour" included the travel, loading and unloading time of a pickup and delivery.

Finally, Jones & Sedor (2006) summarized the efforts of the FHWA to facilitate the development of reliability measures for freight travel. The authors pointed out the Department of Transportation's recognition that the "timely and reliable movement of freight is critical to the Nation's economy." Hence, the FHWA effort concentrated on reliability. The following measures were proposed: fill rate, delay, travel time, travel time reliability (speed & buffer time index), profitability, and return on investment. The latter two measures did not pertain to reliability per se, but recognized the importance of solvency to the freight industry. Fill rate was defined as the percentage of orders delivered on time (i.e., no later than the delivery day requested by the customer).

INDUSTRY PERFORMANCE MEASURES AND CONCERNS

A key distinction between the performance measures "suggested" in the literature, and those actually applied in practice, is the availability of data to compute the measure. Another distinction is the performance measure that can be "influenced by the public sector," and the measure that is "meaningful to stakeholders in the private sector" (Jones and Sedor 2006). Performance measurement experts have also noted that the measures of interest depend on the role (i.e., users, shippers, carriers, authorities) and the geographic scale. The FHWA has ascertained that speed of travel and travel time reliability are two measures that are of interest to both the private and public sectors, particularly for highway-based modes. Several research efforts have addressed these two measures, as well as the technology needed to track the location of trucks; the vehicle location technology is needed for the compilation of travel speeds and times. Another factor is the extent to which the measure addresses a critical industry issue. The following discussion reviews freight performance measures, by mode, that are found in readily-available publications, or that are implied by discussions in industry-related documents.

Commercial Trucking and Multimodal

The use of performance measures in the trucking industry, and perhaps in all freight modes, is vast and extensive. For example, USA Truck, an FTL carrier, indicated that their annual self-assessment involved the use of performance measures in "300 statistical areas." Some performance measures are common to many carriers – regardless of mode – while others are common to carriers within a specific mode. Still other performance measures are customized to one or a few carriers, although many of these are derivatives of a common base (such as "revenue" or "load"). A review of one FTL carrier (USA Truck), one LTL carrier (US Xpress), and one carrier offering both FTL and LTL services (Frozen Food Express)

revealed that the greatest proportion of performance measures was financial. Other performance measurement categories were either equipment- or load and haul-related. Notably, none of the carriers included a congestion- or speed-based measure, although the effects of any shipping delays would ultimately be reflected in financial statements. Three measures were emphasized as being "extremely important" to the industry:

- Average length of haul
- Empty miles factor
- Operating margin or ratio

The average length of haul is self-explanatory. One definition of the empty miles factor is the total number of miles traveled between loads as a percentage of the total miles traveled. The operating margin or ratio is simply a company's operating expenses divided by the operating revenue. Other performance measures being used, in the financial, equipment and load categories, are listed in Table 6. Performance standards vary by carrier; this research did not investigate the different possible criteria.

Table 6. Performance Measures Used by Commercial Vehicle Operators

Financial (annual or year-end)	Equipment	Load and Haul
% of revenue from S&P 500	Average age of revenue equipment	Average length of haul
% of revenue from top customers	Equipment utilization rate	Empty miles factor
After-tax return on equity	Tractor operating life	Freight volume
Annual revenue growth rate	Trailers in service (trailer fleet)	Hundredweight
Average shares outstanding	Trailer operating life	Loaded miles per load
Book value per share	Tractors in service (tractor fleet)	Loaded miles
Claims costs		Pounds per shipment
Debt		Revenue per business day
Debt-to-equity ratio		Revenue per hundredweight
Earnings per share		Revenue per loaded mile
FTL or LTL revenue		Revenue per shipment
FTL/LTL % of revenue		Shipments
Insurance costs		Shipments per business day
Internal rate(s) of return		
Market value per share		
Net capital expenses		
Net income or loss		
Operating expenses		
Operating margin or ratio		
Pre-tax margin		
Return on capital		
Revenue		
Shareholders' equity		
Working capital		

SOURCES: Measures used by Frozen Food Express, US Xpress, and USA Truck.

Other measures in use were customer-oriented, including the number of customers, the proportion of all customers who were returnees, customer duration or dedication, and average collection time (i.e., time period from billing to receipt of payment). Still other measures, not fitting into any of the above categories, included the number of employees, the number of drivers, and the maximum tractor speed. The latter measure was incorporated into one carrier's safety measures. That is, a limit on tractor speed

was being used as a mitigation against excessive highway speed, thus serving as a potential crash prevention action.

The commercial carriers studied tended to address safety in terms of claims costs, liability, and mitigating factors, rather than with crash- or incident-related measures. Claims and tort were, perhaps, consequential measures of incidents, whether vehicle- or load-related. It can be argued that crashes and incidents, along with crash and incident rates, are the most direct measures of safety; it can also be argued, though, that these measures are best recorded on a broad scale (e.g., statewide or nationwide), rather than on a per carrier basis.

For another perspective on performance among commercial carriers, the American Transportation Research Institute identified the trucking industry's critical issues in 2007, based on a survey of trucking companies. The issues point toward performance measures that might be used to assess how well the needs of the trucking industry are being addressed. The critical issues can be grouped into eight subject areas:

- Hours of service regulations
- Driver availability and shortages
- Fuel costs
- Highway congestion
- Toll costs
- Tort and other liability matters
- Environmental controls
- On-board technology

In general, the trucking industry is concerned with heightened regulations that restrict operational flexibility, rising costs (in several areas), the costs of satisfying regulations, the effects of congestion, and improving safety (an outcome of which is tort and associated legal matters). Each of these issues suggests one or more performance measures, as follows:

Hours of service. Fundamental performance measures are the hours of service per driver, and the total hours of service per selected time period, such as a week, month or year. Driver-related measures, determined as an average per driver per selected time period, are the hours of sleep, on-duty hours, and off-duty hours. Other example time periods might be the 60- or 70-hour periods specified in the hours of service legislation.

Driver Availability and Shortages. A rising concern in the trucking industry is driver turnover – annual rates reportedly approach 100% for some carriers. Relevant performance measures include the annual driver turnover rate, driver retention rate, and annual driver recruitment and training costs. Measures related to driver workload include the miles per driver per day, tour length, average circuity per load, and first dispatch empty miles. A "circuity" is a (presumably roundabout) tour; the first dispatch empty miles represent the numerator of the empty miles factor as applied to the first pickup or delivery of the day.

Fuel Costs. The costs of fuel are typically incorporated into a carrier's operating expenses. Rising fuel costs demand a separate consideration, however. Fundamental measures would include the average amount paid per gallon of diesel fuel, the total annual fuel expenses, and fuel efficiency (i.e., average miles per gallon). Similar measures for gasoline or other types of fuel may be applicable for certain truck companies having non-diesel vehicles.

Highway Congestion. As noted above, the FHWA has identified the average speed of travel and travel time reliability as two critical freight performance measures. Many carriers use 47 mph as the average speed at which freight will be transported, regardless of actual traffic conditions. Table 7 shows the car

and truck freeway speed limits in States in which there is a difference. California has the greatest car-truck speed difference (15 mph), although Alabama has the same differential for hazmat trucks. Actual travel speeds vary according to levels of congestion, the time of day of travel, terrain and topography, truck size and load, and truck driver behavior. Peak period congestion can be avoided with travel during non-peak periods, but scheduling and hours of service needs may necessitate travel during the peak. The diagram in Figure 5 shows freeway speeds along the I-10 freeway westbound in the Los Angeles area during the morning peak on a weekday in September 2000. It is evident that the 47 mph assumption would not be applicable to travel along this route at this time of day. The indication is that a more flexible measure of travel speed should be used. One recommendation would be to use different peak and non-peak speeds, along with speeds that are reflective of different geographical areas. Regarding the latter, Table 8 shows year 2005 peak period freeway speeds (calculated, not empirical) in selected very large, large, medium and small urban areas in the U.S. Of the 85 urban areas listed, 23 had freeway speeds less than 47 mph, with the lowest being San Francisco-Oakland (39.4 mph), Chicago (39.1 mph), and Los Angeles-Long Beach-Santa Ana (34.7 mph). Since these data are compiled annually as part of the *Urban Mobility Report* series (e.g., Schrank and Lomax 2007), this is accessible information that could rather easily be adopted by trucking companies.

Table 7. Truck Speed Limit Differentials

State	Statutory car speed limit	Statutory truck speed limit
Alabama	70	55 (hazmat only)
Arkansas	70	65
California	70	55
Idaho	75	65
Illinois	65	55
Indiana	70	65
Michigan	70	60
Montana	75	65
Ohio	65	65 on Ohio Turnpike, 55 on all other freeways.
Oregon	70* never implemented, 65 or less still in effect[96]	5 mph differential, effectively 60[96] although 55 is still posted in most locations
Texas	70-80 mph day/65 mph night	70/65 night
Texas (Farm-to-Market roads only)	70 mph day/65 mph night	60 day/55 night
Washington	70	60

SOURCE: http://en.wikipedia.org/Wiki/Speed_limits_in_the_United_States. <accessed on Sep. 17, 2008>

Toll Costs. Trucking companies have expressed concern about the effects of an increasing number of toll facilities on overall operating expenses. Toll roads have existed for some time in the eastern U.S., but there is a growing number of toll facilities in the western U.S. Fundamental measures might include the proportion of operating expenses devoted to tolls, the total toll costs paid, total toll road mileage, and total toll road mileage as a percent of total mileage.

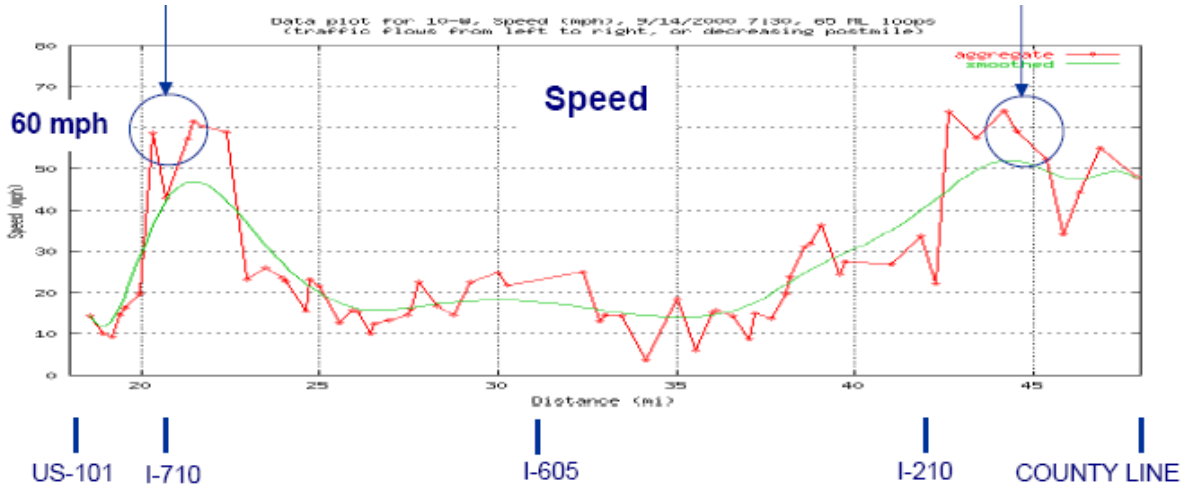


Figure 5. I-10 Westbound Speed Profile, 7:30 am, 9/14/2000 (PeMS data, Univ. of California, Berkeley)

Tort and Liability, Environmental Mitigation, and On-Board Technology. Performance measures associated with these issues were not found in any documentation. Since these were identified as critical issues, the development of performance measures is warranted. Further research, beyond the scope of this study, might identify appropriate measures.

Railroads

As discussed above, the railroad industry is dominated by the Class I railroads, which earned 92% of all freight rail revenue in 2002. As such, the industry performance measures reported are dominated by those pertaining to Class I Railroads. The American Association of Railroads (AAR) serves as a clearinghouse for industry statistics. Statistics that also serve as performance measures include the following. Note that average length of haul and operating ratio, along with revenue and expenses measures, are used by other modes:

- Average length of haul
- Average tons per carload
- Average tons per train
- Carloads originated
- Containers transported
- Employees
- Freight cars in service
- Freight revenue
- Freight revenue per ton-mile
- Locomotives in service
- Net income
- Operating expense
- Operating ratio
- Operating revenue
- Railroad market share
- Return on average equity
- Ton-miles of freight

Table 8. Estimated Average Freeway and Arterial Speeds in Urban Areas, 2005

Urban Area	Freeway	Arterial Street	Urban Area	Freeway	Arterial Street
Very Large			Medium		
Atlanta, GA	42.5	26.8	Akron, OH	56.0	32.4
Boston, MA-NH-RI	45.6	28.3	Albany-Schenectady, NY	57.4	31.0
Chicago, IL-IN	39.1	24.3	Albuquerque, NM	49.9	30.0
Dallas-Fort Worth-Arlington, TX	40.5	28.3	Allentown-Bethlehem, PA-NJ	56.0	29.0
Detroit, MI	47.6	26.4	Austin, TX	45.1	26.6
Houston, TX	40.3	27.4	Birmingham, AL	53.7	29.1
Los Angeles-LBch-Santa Ana, CA	34.7	25.6	Bridgeport-Stamford, CT-NY	47.2	29.9
Miami, FL	42.1	24.9	Charlotte, NC-SC	49.7	27.4
New York-Newark, NY-NJ-CT	40.5	26.1	Dayton, OH	55.7	30.9
Philadelphia, PA-NJ-DE-MD	45.6	27.5	El Paso, TX-NM	49.5	30.3
Phoenix, AZ	42.0	27.9	Fresno, CA	55.7	30.1
San Francisco-Oakland, CA	39.4	25.5	Grand Rapids, MI	58.1	30.5
Seattle, WA	43.2	27.8	Hartford, CT	54.4	30.9
Washington, DC-VA-MD	43.1	25.0	Honolulu, HI	50.3	27.5
			Jacksonville, FL	53.1	26.3
Large			Louisville, KY-IN	48.6	28.1
Baltimore, MD	44.6	27.6	Nashville-Davidson, TN	52.6	28.8
Buffalo, NY	56.1	32.3	New Haven, CT	54.3	31.0
Cincinnati, OH-KY-IN	50.0	30.0	Oklahoma City, OK	56.2	31.5
Cleveland, OH	55.5	31.6	Omaha, NE-IA	53.0	29.4
Columbus, OH	50.2	28.8	Oxnard-Ventura, CA	48.5	28.2
Denver-Aurora, CO	44.1	26.4	Raleigh-Durham, NC	51.9	29.2
Indianapolis, IN	51.9	27.3	Richmond, VA	55.5	31.6
Kansas City, MO-KS	55.8	32.1	Rochester, NY	56.4	31.9
Las Vegas, NV	44.2	27.3	Salt Lake City, UT	52.4	28.0
Memphis, TN-MS-AR	52.2	31.2	Sarasota-Bradenton, FL	58.2	27.8
Milwaukee, WI	49.4	32.1	Springfield, MA-CT	58.1	31.9
Minneapolis-St. Paul, MN	44.7	28.9	Toledo, OH-MI	55.0	32.2
New Orleans, LA	53.3	29.5	Tucson, AZ	50.5	27.9
Orlando, FL	49.9	25.2	Tulsa, OK	58.2	31.1
Pittsburgh, PA	56.1	31.5			
Portland, OR-WA	44.1	27.9	Small		
Providence, RI-MA	52.0	29.9	Anchorage, AK	59.7	31.5
Riverside-San Bernardino, CA	40.6	28.7	Bakersfield, CA	55.3	31.9
Sacramento, CA	43.9	26.2	Beaumont, TX	58.2	33.0
San Antonio, TX	48.8	27.7	Boulder, CO	59.1	30.6
San Diego, CA	40.8	25.8	Brownsville, TX	59.7	32.0
San Jose, CA	43.5	25.7	Cape Coral, FL	58.2	30.0
St. Louis, MO-IL	52.4	29.1	Charleston-No. Charleston, SC	55.3	28.7
Tampa-St. Petersburg, FL	49.5	26.2	Colorado Springs, CO	52.3	30.6
Virginia Beach, VA	50.8	28.9	Columbia, SC	58.1	31.6
			Corpus Christi, TX	57.6	32.6
			Eugene, OR	57.5	30.6
			Laredo, TX	59.4	31.3
			Little Rock, AR	57.5	31.7
			Pensacola, FL-AL	58.9	30.8
			Salem, OR	58.6	30.7
			Spokane, WA	58.7	33.3

Note: 2005 data used in 2007 Urban Mobility Report.

SOURCE: Schrank, D. and T. Lomax, *Urban Mobility Report 2007* (speeds are in mph).

- Tons originated (by commodity)
- Tons originated (total)
- Trailers transported

Individual railroads regularly report three performance measures to the AAR:

- Railcars on line
- Terminal dwell time
- Train speed

"Railcars on line" is the average daily online inventory of freight railcars. Terminal dwell time is the average time a railcar resides at a specified terminal. The train speed is calculated by dividing the train-miles by the total operating time, excluding terminal time. Train speed represents line-haul movement between terminals.

All railroads, including freight and passenger, report their incident data to the Federal Railroad Administration (FRA). Year 2005 freight railroad safety data are summarized in Table 9. Note that the FRA reports incident data by railroad for Class I and Regional operators; such detailed reporting is not done in the motor carrier industry. Safety statistics, which could also serve as performance measures for the individual railroads, include those listed in the table. Incident rates can be used to compare railroads.

Table 9. Safety Statistics for Selected Class I Railroads, 2005

	Total		Hwy.-Rail Grade Xings					
Railroad	Fatalities	Incident Rate	Fatalities	Incident Rate	Employee Injuries Rate	Yard Incidents Rate	Damaged Consists	Hazmat Releases
BNSF	153	3.41	70	2.36	1.53	25.68	128	10
CSX	112	4.39	47	4.67	1.73	24.25	53	5
KCS	13	14.07	7	12.36	2.23	53.50	21	0
Norfolk	NA	NA	55	4.84	1.21	14.66	22	3
UP	167	4.77	63	2.81	2.10	34.84	95	12

NOTES: BNSF = Burlington Northern & Santa Fe; CSX = CSX Transportation; KCS = Kansas City Southern; Norfolk = Norfolk Southern; UP = Union Pacific; Total = all incidents; Incident rates are per million train-miles; Employee injuries rate is per 200,000 (work) hours; Yard incidents rate is per million yard switching train-miles; NA = not available.

Ports and Ships

Chung (1993) noted that the primary performance indicators used by ports are the vessel turnaround time, and the tonnage handled per ship day in port. The vessel turnaround time is the length of stay from time of arrival to time of departure. A variation of turnaround time is dwell time, which is the number of days that a ton of *cargo* (as opposed to a vessel) remains in port. Chung also noted that port productivity is measured by tons per gang hour, and TEUs per crane or hook hour. The former measure applies to general, non-container cargo, in which a work station is referred to as a "gang." The latter measure applies to containers – cranes and hooks are the equipment used to move and place containers. Ports are also concerned with financial performance, such as operating surpluses, operating expenses, possibly as ratios to the tonnage of cargo handled. Total TEUs, total tonnage, trade values (total and by type of cargo), commodity values and volumes, and market shares are also used by the ports to establish benchmarks.

The Maritime Administration (MARAD) maintains a statistical database on the U.S.' 300 or so ports. Each of the statistics, also reflective of performance, measures the level of activity at each port. The port rankings in Table 1 use two of these measures: annual shipment weight and annual TEUs. The other annual measures used include:

- Total calls (all vessels)
- Total capacity of all calls (total metric tons of all ships loaded to water line)
- Total tanker vessel calls and capacity
- Total product vessel calls and capacity
- Total crude oil vessel calls and capacity
- Total container ship calls and capacity (in TEUs)
- Total dry bulk cargo vessel calls and capacity
- Total ro-ro (roll-on roll-off container) vessel calls and capacity

- Total motor vehicle vessel calls and capacity
- Total gasoline carrier vessel calls and capacity (in cubic meters)
- Total combination vessel calls and capacity
- Total general cargo vessel calls and capacity

Marine vessel operators were using performance measures that reflected volume, solvency, efficiency, and safety. Kirby Inland Marine (Holcomb 2004), for example, reported on:

- Delay days (i.e., total delay, measured in days)
- Revenue per ton-mile
- Ton-miles
- Towboats operated

American Commercial Lines reports on its financial and business objectives in its financial statements, as required by the U.S. Securities and Exchange Commission. The performance measures used to determine whether the objectives had been met, in their April 2008 report, were:

- Earnings before interest, taxes, depreciation and amortization (EBITDA)
- Earnings per share (net income divided by outstanding shares)
- Average working capital as a percent of revenue
- Environmental responsibility
- Safety incident rate (recordable injuries * 200,000 divided by number of employee-hours worked)
- Sales, general and administrative expenses as a percent of revenue
- Stationary days reduction for covered hoppers
- Turn rate per 10,000 liquid barges

The stationary days reduction for covered hoppers is analogous to Kirby's delay days, except that the measure concentrates on the amount by which delay was *reduced* in comparison to a previous period. Two environmental responsibility measures were used: the number of notices of violation received from a State agency, and the number of releases (spills) entering into a river. The turn rate is the number of days in the year divided by the average number days required to move a lift on a 10,000 liquid barrel barge. It is interesting to note that the commonly used motor carrier and railroad performance measures of average length of haul and operating ratio are not specifically used by marine vessel companies.

Pipelines

All pipeline operators track their financial performance in terms of standard measures (revenues, expenses, earnings, etc.). The Pipelines and Hazardous Materials Safety Administration (PHMSA) requires all owners of gas transmission pipelines to report on four overall measures of integrity (each of which is related to pipeline safety) (GAO 2006):

- Pipeline miles inspected
- Number of immediate repairs
- Number of scheduled repairs
- Number of leaks, failures and incidents

Mastio and Company, an independent, private group, annually performs customer satisfaction surveys of the gas industry (Mastio 2008). Survey participants include local distribution companies, power producers, marketers, and various industrial users. The 2008 survey results were used to develop 29

attributes of natural gas pipelines; several of the attributes could be reformulated as performance measures, as follows:

- Accuracy of contracts
- Accuracy of scheduled gas volumes
- Attitude of continuous improvement
- Customer service orientation of company representatives
- Ease of contacting right person (accessibility and responsiveness of personnel)
- Effectiveness of after-hours support
- Execution of transportation requests
- Expertise of personnel
- Reliability of gas transportation
- Timeliness of notification prior to restrictions
- Timeliness of problem resolution

Several of the measures are, evidently, qualitative and based on opinions regarding customer service. This is a consequence of the role that many natural gas suppliers fulfill as public utilities. It is interesting to note that the Mastio surveys segregate natural gas pipelines into five categories, generally based on size or geography: mega, major, regional, intrastate, and major organizational groups. Mega pipelines had at least 3,500 miles of pipe and deliveries of at least 1 *trillion* cubic feet. Major pipelines had at least 3,500 miles of pipe and served at least three States. Regional pipelines had at least 3,500 miles of pipe, but served fewer than three States. Intrastate pipelines served one State, while major organizational groups were owner-operators. PG&E, for example, was in both the intrastate and major pipeline categories.

Similarly to natural gas pipelines, the PHMSA has identified several safety-related performance measures for oil or "liquids" pipelines. These are, annually:

- Hazardous liquid pipeline spills in unusually sensitive areas (USAs)
- Number of serious incidents
- Pipeline incidents caused by corrosion
- Pipeline incidents caused by excavation damage
- Time required to close a Corrective Action Order after a safety sensitive incident
- Unrecovered oil spill costs per costs for implementing IMP (Integrity Management Programs) in USAs

Although the PHMSA requires liquids pipeline companies to report their safety-related incidents, only overall pipeline industry safety data are published. This approach is analogous to that in the motor carrier industry. That is, incidents are published for the entire industry as a whole, rather than on a per-carrier basis. In addition to the safety data, liquids pipeline companies such as Magellan and Enbridge Energy reported the following operating statistics to the U.S. Securities and Exchange Commission (SEC):

- Average barrels per day
- Average haul (miles)
- Barrel-miles
- Inland terminal throughput (in millions of barrels)
- Marine terminal average storage capacity utilized per month
- Transportation barrels shipped
- Transportation revenue per barrel shipped

Magellan, Enbridge Energy, and other companies also report standard financial measures to the SEC, including net income, earnings per unit, and EBITDA.

Aviation

An air cargo excellence survey is regularly conducted by *Air Cargo World* magazine, rating airports and air freight carriers. Airports are rated in four areas: performance, value, facilities, and regulatory operations. The performance measures include:

- Amount of allied services (ground handling, trucking)
- Dependability
- Extent to which promises are fulfilled and contractual obligations are met
- Promptness and courtesy of customer service

Although the other three areas are not labeled "performance," aspects of performance are represented in all three. For example, value measures include competitiveness of rates, reasonableness of rates, and availability of value-added programs. Facilities measures refer to the size and adequacy of infrastructure, such as aprons, warehousing, accommodation of perishables, access to highways, and access to other modes of transport. Regulatory measures focus on the adequacy and integrity of customs, security, and a foreign trade zone. Airports are grouped into three categories: 1 million or more tons of freight annually, 500,000 to 999,999 tons, and less than 500,000 tons. Each airport is scored in each of the four areas by survey participants, each of whom rates the airport on a scale of one to five. The participants' scores are summed and normalized (within each of the three airport groups), such that the average air cargo terminal has a value of 100. Thereby, airports with a score of greater than 100 are *above* average. Table 10 lists the above average airports. The Memphis, Tennessee and Seoul Incheon (South Korea) airports were the highest-rated in the one million and more tons of cargo category, with scores of 114; Osaka was highest in the 500,000 to 999,999 tons group, with Dallas-Ft. Worth the highest in the U.S. in this group; Nagoya was highest in the less than 500,000 tons group, with Houston Intercontinental the highest in the U.S. in this group. A total of 51 airports worldwide were "above average," 17 of which were in the U.S.

The air cargo excellence survey also rates air carriers, in five areas: customer service, performance, value, and information technology. Each airline is scored in each of the five areas in a similar manner as the airports, as explained above. Areas of performance addressed in the survey include:

- Accomplishment of scheduled transit times
- Dependability
- Extent to which promises are fulfilled and contractual obligations are met

Areas of customer service include expedience with which claims are handled, promptness and courtesy with which problems are solved, and professionalism and knowledge of sales force. Value measures are similar to those used to evaluate airports. Finally, information technology measures include the efficiency and capabilities of the air cargo carrier in tracking and tracing shipments, Internet ordering and processing, and electronic commerce. Air cargo carriers with a score of greater than 100 are above average. The world's "top 50 airlines" in the 2008 survey are shown in Table A2, in the Appendix. Lufthansa was the world leader, with an overall score of 124, and top scores of 131 in information technology and 125 in customer service. Swiss WorldCargo led in the performance category, with a score of 124, while Emirates SkyCargo led in the value category, with a score of 119. The top U.S.-based air cargo carrier was FedEx, with an overall score of 115.

Table 10. Above Average Air Cargo Terminals (*Air Cargo World,* "Air Cargo Excellence Survey," 2008)

Airport	Performance	Value	Facilities	Regulatory	Overall
≥ 1 million tons annually					
Memphis	116	115	115	111	114
Seoul Incheon	113	113	116	115	114
Amsterdam	107	109	108	112	109
Frankfurt	109	106	108	109	108
Anchorage	107	107	105	108	107
Hong Kong	106	105	105	103	105
Tokyo Narita	105	105	102	102	104
Louisville	100	104	103	102	102
Dubai	99	101	106	103	102
Chicago O'Hare	100	102	102	98	101
Singapore	99	99	104	101	101
500,000-999,999 tons annually					
Osaka	110	109	108	110	109
Shenzen	106	110	106	108	108
Dallas-Ft. Worth	110	106	109	105	107
Cologne-Bonn	107	104	111	105	107
Atlanta	104	104	105	104	104
Tokyo Haneda	106	98	100	99	101
< 500,000 tons annually					
Nagoya	120	115	115	121	118
Munich	117	114	116	118	116
London Gatwick	110	114	114	113	113
Houston Intercontinental	112	113	112	112	112
Zurich	115	107	108	114	111
Vancouver	108	112	112	107	110
Helsinki	109	107	109	112	109
Frankfurt-Hahn	108	109	104	109	108
Abu Dhabi	110	102	106	106	106
Montreal Trudeau	106	105	104	104	105
London Stansted	105	106	104	106	105
Stockholm	104	106	107	102	105
Santiago	106	109	101	105	105
Seattle-Tacoma	103	105	107	103	104
Orlando	103	101	106	105	104
Copenhagen	103	107	108	100	104
Denver	103	102	103	103	103
Manchester	107	106	101	100	103
East Midlands	103	107	101	102	103
Liege	100	102	100	109	103
Salt Lake City	105	103	104	98	102
Ft. Worth Alliance	102	99	104	105	102
Detroit	103	101	102	103	102
Buenos Aires	104	98	103	103	102
Bahrain	105	101	102	100	102
Shanghai Honqiao	101	101	101	104	102
Minneapolis-St. Paul	104	103	100	98	101
Portland	104	99	99	101	101
Phoenix	99	100	104	100	101
Baltimore-Washington	98	103	98	103	101
Athens	103	95	100	108	101
New Delhi	101	102	98	103	101
Macau	99	101	101	103	101
Sharjah	97	99	106	102	101

OTHER MODES

The performance measurement practices of local messenger and small delivery services were not identified during the research conducted for this study. Only one publication, by IBISWorld (an industry think tank), addressed this sector of the freight transport industry. The IBISWorld measures focused on industry performance, and were generally financial. A few measures that might be specific to the sector were discussed in the report, including:

- Disposable income levels in market service area
- Number of households in service area
- Number of businesses in service area
- Reliability of delivery (particularly critical in this sector)
- Speed of delivery (also critical in this sector)
- Accuracy of delivery (also critical; the concern is with correct-address delivery)
- Internet connections (a measure of competition with traditional messengers and delivery)

CONCLUSION

Performance measurement in freight transportation is practiced on a broad scale. No uniform guidance on performance measures in freight transport exists, so the measures and applications used in practice lack uniformity. This issue is currently being addressed, in part, by the NCFRP initiative described in the opening section of this report. One finding is that the performance measures used by freight transport providers are not the same ones in use by or of interest to the public sector. A fundamental reason for the different interests is that the industries surrounding the various freight transportation modes were deregulated some time ago, enabling open competition. Although the Surface Transportation Board, Federal Maritime Commission, Federal Aviation Administration, Federal Motor Carriers Safety Administration, Pipelines and Hazardous Materials Safety Administration, and other federal and State agencies regulate some aspects of the freight transport modes, the operators are generally free to function as businesses in a market. Thus, many of the performance measures used by the providers are financial and customer service oriented. Load and haul measures are also commonly used. Employee-related measures are used, as well, although there is little similarity in their forms. Travel speed measures are used, although some providers seem to use financial performance as a consequence of delay, rather than direct measures of delay. Nonetheless, the FHWA has identified average travel speed and travel time reliability as the two key freight transport performance measures. It is anticipated that these measures will "catch on" in the industry, in all of the modes. Now that the measures have been identified, the FHWA has diverted its attention to the data collection technology needed to develop the speed and reliability measures. It is likely that the technologies will need further development before there is widespread implementation of speed and reliability measures.

A second finding is that there are modal differences that, by necessity, require different performance measures. For example, ports keep track of marine vessels that are specific to the type of cargo transported; thus, performance measures such as crude oil tanker calls and dry bulk cargo vessel capacity are used. In contrast, the trucking industry does not similarly record cargo by truck type – the emphasis is toward weight, distance and value. A third finding is that a handful of measures are used by many, if not most, of the providers in nearly all freight transport modes:

- Average length of haul
- Operating ratio
- Revenue per ton-mile
- Tonnage (total, all loads)
- Ton-miles or barrel-miles
- Terminal dwell time or empty miles factor

Belman and White (2005) characterized the average length of haul as a measure of productivity, noting that there had been increases in several commercial vehicle sectors. Changes in this measure, according to these authors, could be related to load consolidation, route optimization, and-or the use of dedicated fleets. The measure can be negatively affected by congestion, particularly if a time constraint is associated with a haul. The operating ratio is one of the simplest measures of financial performance. Interestingly, many freight transport providers – particularly the motor carriers – function at very high operating ratios (i.e., revenues and expenses are nearly equal). Railroad operating ratios tend to be lower, around 80%, and may suggest a potential for greater profitability. Given that how an operator defines revenue and expenses, or what is included in these, can vary, it is difficult to pinpoint an exact interpretation of the operating ratio in each individual case. The consensus, however, is that a high operating ratio is suggestive of an inability to cover costs.

Revenue per ton-mile, tonnage and ton-miles (or barrel-miles) are all load- and haul-related measures. Ton-miles, in particular, are tabulated across all modes on national and international scales, and are used as key benchmark of freight movement activity. The four main freight modes – trucks, railroads, ships and pipelines – are surprisingly well balanced in the U.S. in terms of their proportions of total ton-mileage. It is interesting that the balance exists amidst deregulated industries, although it is not clear if deregulation precipitated the balance, or if there is a gradually evolving shift toward certain freight transport modes. Ton-miles, as a measure, has been criticized for not distinguishing between the affects of productivity and consist (vehicle or vessel size) changes (Levine 1985). The measure affects goods movement policy decisions despite this flaw (Gerondeau 1996). Ideally policy and corporate decisions should also consider other performance measures.

Finally, terminal dwell time and the empty miles factor are measures of "unproductive time." Freight transport providers probably try to reduce these measures, to improve efficiency and productivity. If containers are used, then the manner in which they are stacked and stored becomes a function of dwell time (Huynh 2007). Vachal and Bitzan (2005) noted that dwell time was positively correlated with transportation price, in part because of the negative effect of dwell time on system capacity. The empty miles factor is an alternative "version" of dwell time, in that it is a measure of empty vessel movement. The measure is used primarily by motor carriers, perhaps because the other modes have greater control over the movement of empty vessels. Jordan and Burns (1984) noted that the empty miles factor could be reduced by backhauling (carrying a load from the destination back to the origin). Ultimately, however, the empty miles factor might be minimized by optimizing terminal, plant and distribution center locations, relative to supplier selection decisions. It is not clear to what extent motor carriers attempt to optimize these aspects of their businesses.

This study is merely an overview and general assessment of current performance measurement practices in freight transportation. It is anticipated that the findings of NCFRP Project 03 will point toward the establishment of performance measures that are uniform and intermodal.

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Table A1. Leading Commercial Motor Vehicle Carriers in 2006 (from *Commercial Carrier Journal*, Aug. 2007)

THE TOP 100

				Revenue (in 000)			Equipment								Drivers		
Overall Blended Rank	Company	City & State	Industry Segment	2004	2003	% change	All Trucks & Tractors	Total Trucks	Total Tractors	Total Trailers	Owned Trucks & Tractors	Owned Trailers	Leased Trucks & Tractors	Leased Trailers	Company Drivers	Owner-Operators	Total Drivers
1	United Parcel Service, Inc.	Atlanta, GA	LTL Package	$36,582,000	$33,485,000	9.2	75,774	65,367	10,407	46,331	75,774	46,331	0	0	87,544	0	87,544
2	FedEx Express	Memphis, TN	LTL Package	19,485,000	17,497,000	11.4	39,554	36,626	2,928	4,701	39,554	4,701	0	0	53,646	0	53,646
3	DHL Worldwide Express, Inc.	Plantation, FL	LTL Package	8,568,000	5,455,000	57.1	20,323	19,711	612	830	8,511	400	11,812	430	9,110	12,340	21,450
4	Swift Transportation Co., Inc.	Phoenix, AZ	TL General Freight	2,826,201	2,397,655	17.9	18,545	0	18,545	51,773	14,898	51,773	3,647	0	18,500	3,647	22,147
5	FedEx Ground, Inc.	Coraopolis, PA	LTL Package	4,677,000	3,912,000	19.6	16,979	13,062	3,917	19,744	1,190	19,744	15,789	0	19,419	0	19,419
6	Schneider National Carriers, Inc.	Green Bay, WI	TL General Freight	3,200,000	2,905,000	10.2	13,634	0	13,634	45,792	8,773	43,400	4,861	2,392	10,651	5,200	15,851
7	J B Hunt Transport, Inc.	Lowell, AR	TL General Freight	2,786,200	2,433,469	14.5	11,452	0	11,452	48,317	10,151	4,180	1,301	44,137	11,483	1,301	12,784
8	FedEx Freight, Inc.	Memphis, TN	LTL General Freight	3,217,000	2,689,000	19.6	9,248	145	9,103	26,030	9,245	25,927	3	103	11,982	103	12,085
9	Roadway Express, Inc.	Akron, OH	LTL General Freight	3,180,600	2,844,214	11.8	9,507	147	9,360	32,096	6,604	29,994	2,903	2,102	12,267	0	12,267
10	Yellow Transportation, Inc.	Overland Park, KS	LTL General Freight	3,152,045	2,788,078	13.1	8,092	101	7,991	32,784	8,092	32,784	0	0	13,149	0	13,149
11	Con-Way Transportation Services	Ann Arbor, MI	LTL General Freight	2,604,004	2,212,692	17.7	7,555	165	7,390	21,800	7,555	21,800	0	0	12,600	0	12,600
12	Werner Enterprises, Inc.	Omaha, NE	TL General Freight	1,678,043	1,457,766	15.1	10,125	0	10,125	23,670	9,134	23,670	991	0	10,449	991	11,440
13	USF LTL Trucking	Chicago, IL	LTL General Freight	2,005,330	1,898,668	5.6	6,872	107	6,765	17,616	6,872	17,616	0	0	10,887	0	10,887
14	Landstar Carrier Group	Jacksonville, FL	TL General Freight	1,454,862	1,227,171	18.6	8,291	0	8,291	14,215	0	0	8,291	14,215	0	8,291	8,291
15	Overnite Transportation Co.	Richmond, VA	LTL General Freight	1,647,461	1,475,463	11.7	6,078	108	5,970	19,304	5,663	18,447	415	857	6,450	0	6,450
16	ABF Freight System, Inc.	Fort Smith, AR	LTL General Freight	1,585,384	1,347,078	17.7	4,173	81	4,092	20,287	4,173	20,287	0	0	6,925	0	6,925
17	U S Xpress, Inc.	Chattanooga, TN	TL General Freight	1,105,656	930,500	18.8	5,451	0	5,451	16,437	4,868	16,437	583	0	6,010	751	6,761
18	United Van Lines LLC	Fenton, MO	TL Household Goods	1,273,353	1,163,437	9.4	7,990	2,557	5,433	8,181	0	0	7,990	8,181	0	0	5,987
19	Ryder Integrated Logistics, Inc.	Miami, FL	TL General Freight	1,421,199	1,459,603	-2.6	4,807	789	4,018	6,917	0	0	4,807	6,917	6,188	0	6,188
20	Estes Express Lines	Richmond, VA	LTL General Freight	1,008,651	864,813	16.1	4,935	167	4,768	18,133	4,935	18,133	0	0	5,083	0	5,083
21	Crete Carrier Corp.	Lincoln, NE	TL General Freight	820,636	745,721	10.0	5,400	0	5,400	12,500	5,400	12,500	0	0	5,167	0	5,167
22	Allied Systems, Ltd.	Decatur, GA	TL Motor Vehicle	895,213	865,463	3.4	4,843	0	4,843	4,843	3,700	3,700	1,143	1,143	3,900	690	4,590
23	Old Dominion Freight Line, Inc.	Thomasville, NC	LTL General Freight	824,051	667,531	23.4	3,783	44	3,739	14,273	3,783	14,273	0	0	4,485	100	4,585
24	Watkins Motor Lines, Inc.	Lakeland, FL	LTL General Freight	931,191	865,676	7.6	3,109	39	3,070	9,871	1,566	9,871	1,543	0	2,602	1,543	4,145
25	Covenant Transport, Inc.	Chattanooga, TN	TL Gen. Frt. & Refrig.	605,622	582,457	3.6	3,476	0	3,476	8,867	1,953	1,220	1,523	7,647	5,643	301	5,944
26	Averitt Express, Inc.	Cookeville, TN	LTL General Freight	704,233	625,948	12.5	3,537	39	3,498	10,221	3,537	10,221	0	0	4,074	0	4,074
27	CRST	Cedar Rapids, IA	TL General Freight	617,627	525,362	17.6	3,035	0	3,035	4,287	1,315	3,290	1,720	997	2,679	1,823	4,502
28	Atlas Van Lines, Inc.	Evansville, IN	TL Household Goods	689,391	614,125	12.3	4,545	1,711	2,834	4,252	3	460	4,542	3,792	0	0	3,271
29	Penske Logistics, Inc.	Reading, PA	TL General Freight	866,000	654,569	32.3	2,783	328	2,455	5,379	238	1,300	2,545	4,079	4,023	0	4,023
30	Quality Distribution	Tampa, FL	TL Petroleum Products	622,015	565,440	10.0	3,550	0	3,550	7,377	714	5,694	2,836	1,683	293	1,717	3,195
31	Sala Motor Freight Line, Inc.	Duluth, GA	LTL General Freight	645,374	520,668	24.0	2,619	30	2,589	8,263	2,619	8,263	0	0	3,292	11	3,303
32	C R England, Inc.	West Valley City, UT	TL Refrigerated Solids	517,844	499,881	3.6	2,643	0	2,643	4,009	1,435	4,009	1,208	0	2,550	1,092	3,642
33	Celadon Trucking Service, Inc.	Indianapolis, IN	TL General Freight	440,000	367,105	19.9	2,708	8	2,700	7,200	2,308	7,200	400	0	2,800	500	3,300
34	Interstate Distributor Co.	Tacoma, WA	TL General Freight	433,505	369,000	17.5	2,700	0	2,700	6,000	2,400	6,000	300	0	3,000	300	3,300
35	Knight Transportation, Inc.	Phoenix, AZ	TL General Freight	442,288	340,069	30.1	2,818	0	2,818	7,126	2,574	7,126	244	0	2,659	244	2,903
36	New Prime, Inc.	Springfield, MO	TL General Freight	555,942	535,415	3.8	2,572	0	2,572	3,956	258	3,956	2,314	0	290	303	3,064
37	Mayflower Transit/Aero Mayflower	Fenton, MO	TL Household Goods	484,401	419,959	15.3	3,293	1,094	2,199	3,135	0	0	3,293	3,135	0	0	2,487
38	Heartland Express, Inc. of Iowa	Coralville, IA	TL General Freight	457,086	405,116	12.8	2,682	0	2,682	7,133	2,447	7,133	235	0	2,467	235	2,702
39	Kenan Advantage Group	Canton, OH	TL Petroleum Products	459,000	365,000	25.8	2,152	0	2,152	2,555	1,579	2,555	573	0	2,665	670	3,335
40	Southeastern Freight Lines, Inc.	Columbia, SC	LTL General Freight	565,186	483,811	16.8	2,236	7	2,229	7,039	2,236	7,039	0	0	2,971	0	2,971
41	Velocity Express	Westport, CT	LTL Package	287,918	307,138	-6.3	4,730	4,693	37	205	730	190	4,000	15	935	4,000	4,935
42	Dynamex	Dallas, TX	LTL Package	287,856	250,801	14.8	4,930	4,930	0	0	1,430	0	3,500	0	900	3,500	4,400
43	FFE Transportation Services, Inc.	Dallas, TX	TL Refrigerated Solids	474,400	422,000	12.4	2,289	0	2,289	4,147	1,573	4,134	716	13	1,823	715	2,538
44	Contract Freighters, Inc.	Joplin, MO	TL General Freight	400,443	362,174	10.6	2,480	0	2,480	7,010	2,031	7,002	449	8	2,158	449	2,607
45	Gainey Corp.	Grand Rapids, MI	TL General Freight	334,600	310,400	7.8	2,400	0	2,400	5,500	2,400	5,500	0	0	2,900	0	2,900
46	National Freight, Inc.	Vineland, NJ	TL General Freight	590,031	471,345	25.2	1,944	27	1,917	6,585	1,944	6,585	0	0	1,892	85	1,977
47	Marten Transport, Ltd.	Mondovi, WI	TL Refrigerated Solids	380,048	334,667	13.6	2,283	0	2,283	3,152	1,726	3,152	557	0	1,752	557	2,309
48	Stevens Transport, Inc.	Dallas, TX	TL Refrigerated Solids	371,000	294,254	26.1	2,072	0	2,072	2,970	1,792	2,970	280	0	2,420	280	2,700
49	AAA Cooper Transportation	Dothan, AL	LTL General Freight	447,137	408,004	9.6	1,890	32	1,858	4,704	1,890	4,704	0	0	2,170	0	2,170
50	Dart Transit Co.	St. Paul, MN	TL General Freight	404,159	351,345	15.0	2,206	0	2,206	7,300	0	7,300	2,206	0	0	2,206	2,206

THE TOP 100

Overall Blended Rank	Company	City & State	Industry Segment	Revenue (in 000) 2004	2003	% change	Equipment All Trucks & Tractors	Total Trucks	Total Tractors	Total Trailers	Owned Trucks & Tractors	Owned Trailers	Leased Trucks & Tractors	Leased Trailers	Drivers Company Drivers	Owner-Operators	Total Drivers
51	USA Truck, Inc.	Van Buren, AR	TL General Freight	$363,105	$298,663	21.6	2,230	0	2,230	5,682	2,186	5,682	44	0	2,218	44	2,262
52	Bridge Terminal Transport, Inc.	Charlotte, NC	TL Marine Drayage	260,000	not avail.	N.A.	2,400	0	2,400	0	0	0	2,400	0	0	2,400	2,400
53	TNT Logistics North America, Inc.	Jacksonville, FL	TL General Freight	739,000	572,291	29.1	1,469	257	1,212	3,221	16	1,467	1,453	1,754	1,042	660	1,702
54	Central Freight Lines, Inc.	Waco, TX	LTL General Freight	386,601	389,696	-0.8	2,036	43	1,993	8,624	2,036	8,624	0	0	1,840	0	1,840
55	PAM Transportation Services	Tontitown, AR	TL General Freight	325,066	293,547	10.7	1,857	0	1,857	4,257	1,857	4,257	0	0	2,237	0	2,237
56	Pacer International, Inc.	Concord, CA	TL General Freight	406,000	345,000	17.7	1,524	0	1,524	1,106	0	282	1,524	824	100	1,415	1,515
57	Mercer Transportation Co., Inc.	Louisville, KY	TL General Freight	293,660	230,497	27.4	1,638	0	1,638	1,638	0	0	1,638	1,638	0	1,638	1,638
58	Ace Transportation, Inc.	Lafayette, LA	TL Heavy Hauling	237,380	261,119	-9.1	1,821	489	1,332	1,332	0	0	1,821	1,332	0	2,120	2,120
59	KLLM, Inc.	Richland, MS	TL General Freight	264,727	251,889	5.1	1,601	0	1,601	2,684	1,447	2,684	154	0	1,468	154	1,622
60	Cardinal Freight Logistics Mgmt.	Concord, NC	TL General Freight	264,694	200,033	32.3	1,586	263	1,323	3,787	385	1,475	1,201	2,312	368	1,201	1,569
61	The Shevell Group of Companies	Elizabeth, NJ	LTL General Freight	389,000	329,000	18.2	1,289	69	1,220	3,332	1,289	3,332	0	0	1,500	0	1,500
62	Roehl Transport, Inc.	Marshfield, WI	TL General Freight	206,506	184,649	11.8	1,571	6	1,565	3,002	1,517	3,000	54	2	1,588	0	1,642
63	Western Express, Inc.	Nashville, TN	TL General Freight	224,738	198,000	13.5	1,436	0	1,436	2,290	1,378	2,290	58	0	1,576	112	1,688
64	Jevic Transportation, Inc.	Delanco, NJ	LTL General Freight	336,896	306,691	9.8	1,273	0	1,273	2,644	1,273	2,644	0	0	1,432	0	1,432
65	Arnold Transportation Services, Inc.	Jacksonville, FL	TL General Freight	199,400	175,651	13.5	1,524	0	1,524	4,500	1,012	4,500	512	0	1,040	512	1,552
66	RoadLink USA, Inc.	Jacksonville, FL	TL General Freight	187,000	178,000	5.1	1,584	24	1,560	1,000	144	350	1,440	650	250	1,250	1,500
67	ATS, Inc.	St. Cloud, MN	TL Heavy Hauling	422,718	359,931	17.4	1,167	0	1,167	2,605	460	2,605	707	0	416	707	1,123
68	Eagle Global Log. Local Divy. Oper.	Houston, TX	LTL General Freight	289,800	254,500	13.9	1,274	933	341	132	43	122	1,231	10	98	1,950	2,048
69	Transport Corp. of America, Inc.	Eagan, MN	TL General Freight	258,408	258,859	-0.2	1,003	0	1,003	4,897	1,003	4,897	0	0	963	610	1,598
70	Arrow Trucking Co.	Tulsa, OK	TL Flatbed Loads	183,000	150,438	21.6	1,400	0	1,400	3,000	0	0	1,400	3,000	1,200	200	1,400
71	Dallas & Mavis Specialized Carrier	Kenosha, WI	TL Heavy Hauling	175,000	not avail.	N.A.	1,269	27	1,242	1,466	0	0	1,269	1,466	0	1,265	1,265
72	Smithway Motor Xpress, Inc.	Fort Dodge, IA	TL General Freight	189,001	165,329	14.3	1,239	0	1,239	2,101	794	2,101	445	0	757	445	1,202
73	New Penn Motor Express, Inc.	Lebanon, PA	LTL General Freight	260,572	216,478	20.4	808	64	744	1,641	808	1,641	0	0	1,441	0	1,441
74	Gordon Trucking, Inc.	Pacific, WA	TL General Freight	163,000	152,700	6.7	1,115	0	1,115	3,152	1,000	3,152	115	0	1,140	125	1,265
75	Superior Bulk Logistics, Inc.	Oak Brook, IL	TL Chemicals & Edibles	204,626	199,887	2.4	1,124	0	1,124	2,189	839	1,957	285	232	714	304	1,018
76	Vitran Express, Inc.	Indianapolis, IN	LTL General Freight	374,595	331,826	12.9	703	1	702	2,239	676	2,239	27	0	835	421	1,256
77	Acme Truck Line, Inc.	Harvey, LA	TL Heavy Hauling	122,316	106,459	14.9	1,308	303	1,005	885	0	50	1,308	835	0	1,494	1,494
78	Paschall Truck Lines, Inc.	Murray, KY	TL General Freight	208,615	187,733	11.1	975	0	975	3,150	800	3,150	175	0	850	185	1,050
79	Cassens Transport Co.	Edwardsville, IL	TL Motor Vehicle	204,450	181,484	12.7	1,210	0	1,210	1,213	1,210	0	0	1,213	926	0	926
80	Pitt Ohio Express LLC	Pittsburgh, PA	LTL General Freight	221,389	205,470	7.7	920	308	612	1,570	920	1,570	0	0	1,374	0	1,374
81	The Waggoners Trucking	Billings, MT	TL Motor Vehicle	201,247	186,380	8.0	1,036	0	1,036	1,036	833	1,021	203	15	760	210	970
82	Jack Cooper Transport Co., Inc.	Kansas City, MO	TL Motor Vehicle	218,728	208,397	5.0	1,108	0	1,108	1,110	1,050	1,052	58	58	893	0	893
83	Cowan Systems LLC	Baltimore, MD	TL General Freight	136,650	112,707	21.2	1,101	1	1,100	2,000	701	2,000	400	0	750	400	1,150
84	Boyd Bros. Transportation, Inc.	Clayton, AL	TL Building Materials	154,285	105,410	46.4	1,001	0	1,001	1,452	655	1,452	346	0	635	346	981
85	Groendyke Transport, Inc.	Enid, OK	TL Petroleum Products	157,520	138,167	14.0	1,030	0	1,030	1,645	840	1,318	190	327	950	0	950
86	Maverick Transportation, Inc.	North Little Rock, AR	TL General Freight	166,026	130,832	26.9	960	0	960	1,073	960	1,073	0	0	942	0	942
87	Ruan Transport Corp.	Des Moines, IA	TL Petroleum Products	not avail.	352,406	N.A.	2,671	21	2,650	5,300	2,671	5,300	0	0	2,756	0	2,756
88	Commercial Carrier Corp.	Auburndale, FL	TL General Freight	120,000	118,701	1.1	1,090	0	1,090	2,423	1,050	2,423	40	0	1,110	40	1,150
89	USF Glen Moore, Inc.	Carlisle, PA	TL General Freight	133,725	128,072	4.4	969	0	969	3,350	848	3,300	121	50	982	121	1,103
90	North American Van Lines, Inc.	Fort Wayne, IN	TL Household Goods	not avail.	590,176	N.A.	3,078	947	2,131	3,255	1	1,035	3,077	2,220	0	0	3,007
91	Milan Express Co., Inc.	Milan, TN	LTL General Freight	141,492	120,323	17.6	847	10	837	1,915	825	1,915	22	0	936	22	958
92	Motor Cargo, Inc.	North Salt Lake, UT	LTL General Freight	180,900	160,100	13.0	817	56	761	2,895	817	2,895	0	0	888	0	888
93	Allied Van Lines, Inc.	Westmont, IL	TL Household Goods	not avail.	416,799	N.A.	3,206	1,004	2,202	3,313	2	261	3,204	3,052	0	0	3,015
94	Navajo Express, Inc.	Denver, CO	TL Refrigerated Solids	150,972	141,417	6.8	856	0	856	1,300	856	1,300	0	0	881	0	881
95	Wilson Trucking Corp.	Fishersville, VA	LTL General Freight	134,758	123,224	9.4	906	122	784	1,633	906	1,633	0	0	882	0	882
96	Enterprise Transportation Co.	Houston, TX	TL Petroleum Products	144,370	129,736	11.3	803	0	803	1,301	687	1,301	116	0	730	121	851
97	Venture Transport Logistics LLC	Houston, TX	TL General Freight	101,227	99,398	1.8	1,078	408	670	825	0	22	1,078	803	0	1,078	1,078
98	R+L Transfer, Inc.	Wilmington, OH	LTL General Freight	not avail.	not avail.	N.A.	2,400	300	2,100	6,000	2,400	6,000	0	0	1,500	0	1,500
99	Panther II Transportation	Medina, OH	TL General Freight	155,000	131,000	18.3	735	435	300	458	0	0	735	458	0	1,537	1,537
100	Roadrunner-Dawes Transport, Inc.	Milwaukee, WI	LTL General Freight	335,971	301,307	11.5	685	3	682	1,493	0	712	685	781	0	682	682

Table A2. Top Air Cargo Carriers (*Air Cargo World*, "Air Cargo Excellence Survey," Mar. 2008)

Top 50 Airlines

Air Carrier	Customer Service	Performance	Value	Information Technology	Overall
Lufthansa	125	123	115	131	124
Swiss WorldCargo	125	124	118	119	122
Emirates Sky Cargo	121	120	119	125	121
KLM	121	122	118	122	121
Japan Airlines	118	119	114	123	118
EVA Air Cargo	117	118	117	119	117
Cathay Pacific	115	118	115	118	116
Virgin Atlantic	116	122	112	116	116
Korean Air	114	117	113	121	116
Nippon Cargo Airlines	117	117	113	119	116
FedEx	110	115	104	132	115
Thai Airways	115	115	115	115	115
Singapore Airlines	112	118	108	119	114
UPS Air Cargo	111	111	110	121	113
Cargolux	117	115	110	109	113
Continental Airlines	115	115	108	113	113
Southwest Airlines	113	114	115	105	112
All Nippon Airways	113	112	107	114	111
SAS	110	111	108	116	111
British Airways	112	108	108	116	111
United Airlines	108	110	111	115	111
Etihad Airways	106	110	113	113	110
US Airways	113	109	107	108	109
Northwest Airlines	107	108	106	108	107
China Airlines	103	109	108	109	107
Air France	105	107	104	110	107
Malaysia Airlines	105	105	107	108	106
Austrian Cargo	111	105	104	103	106
American Airlines	104	102	103	113	105
Qatar Airways	105	105	106	105	105
El Al	105	105	105	104	105
Martinair	107	105	100	101	104
Asiana Airlines	102	103	105	103	103
Qantas	102	103	101	106	103
BAX Global	102	105	99	104	102
bmi British Midland	102	99	104	103	102
Air New Zealand	103	102	101	99	101
Gulf Air	99	104	105	96	101
South African Airways	103	102	100	97	101
Air Canada	102	102	98	100	100
Polar Air Cargo	114	101	98	96	100
Air China	98	99	108	94	100
Dragonair	94	98	97	107	99
LAN Chile Airlines	102	100	96	98	99
Evergreen Int'l Airline	95	96	96	107	99
Pacific Air Cargo	102	95	101	96	98
Iberia	98	99	100	96	98
TAP Air Portugal	99	98	98	98	98
Cargojet Airways	103	97	99	91	98
Aeromexpress	99	102	101	87	97