Origin-to-Destination Trip Times and Reliability of Rail Freight Services in North American Railroads

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Origin-to-destination (O-D) trip times and reliabilities of railroad freight cars as well as car cycle times of selected rail freight services during the period from 1990 to 1991 are documented. Trip times and reliabilities were obtained from samples of car movements obtained from the Association of American Railroad's Car Cycle Analysis System. All car cycles completed during a 12-month period were extracted for a 10 percent sample of boxcars, grain service covered hoppers, and double-stack intermodal cars. Cycle time information was obtained by using the entire sample for each car type. Trip times and reliabilities were obtained for the largest O-D car movements. Altogether, 477 general merchandise O-D movements, 102 unit train O-D movements, and all O-D movements over the 10 largest double-stack corridors were considered. The study covers movements throughout the United States and Canada. Clear differences in trip times and reliabilities were found for the three services. For general merchandise cars the average loaded trip time was 8.8 days and the average 2-day-percent (the maximum percentage of cars with trip times falling within a 48-hr window) was just under 50 percent. For unit grain train service in 1991 the average loaded trip time was 5.3 days and the average 2-day-percent was just over 60 percent. For double-stack train service in 1991 the average ramp-to-ramp trip time was just under 3 days in the long-haul markets (greater than 24,140 km (1,500 mi)) and just over 1 day for the short-haul markets; for both long- and short-haul services the 1-day-percent was about 90 percent. The average car cycle was 6.2 days for double-stack cars, 15.3 days for covered hopper cars in unit train service, 24.1 days for non-unit train covered hopper cars, and 26.9 days for boxcars.

Improving service quality has become a more important issue to the railroad industry in this era of deregulation, initiated by the Staggers Act in 1980. Freight transportation service can be measured by a number of factors such as price, trip times, reliability, and other customer services. Surveys of shippers have frequently cited both the importance of service reliability in mode and carrier selections and the railroad's inability to achieve the high standards for reliability established by the trucking industry (*1,2*).

Knowledge of actual service levels is helpful in providing an understanding of the nature of and the potential approaches to improving rail reliability. This paper documents the trip times and reliabilities of rail freight cars in their movement from the rail origin to the rail destination during the period from 1990 to 1991. It also examines how railroads are currently differentiating services among different groups of freight traffic as part of a broader study of service differentiation in rail freight transportation (*3,4*).

It should be noted that the rail origins and destinations are not necessarily the origins and destinations of the shipments being carried, and hence these car times and reliabilities do not necessarily correspond to the times and reliabilities of greatest interest to shippers. In the case of merchandise traffic in boxcars, which usually move between shippers' and consignees' sidings, there would be a close correspondence. In the case of unit train service much traffic could move between private sidings, but much could also move between various types of public terminal facilities for transshipment to other modes to complete the origin-to-destination (O-D) connection. In the case of intermodal double-stack service, the rail portion—terminal ramp to terminal ramp—clearly omits the terminal times and movements by water or truck to and from the shipment origin and destination. This must be borne in mind in interpreting the results.

Railroads have provided various types of train services for different groups of freight traffic, dividing it into at least three major types: general merchandise train service, unit train service, and intermodal train service. For each category of train service a number of different kinds of car equipment can be used depending on the characteristics of the shipments or special loading and loading requirements. In the present study car cycle information for the following three car types was collected: boxcar data for general merchandise train service, covered hopper car data for unit train service, and double-stack car data for intermodal train service. Transit times and various reliability measures were evaluated and compared for different train services.

Many empirical studies have examined the reliability of rail service, but most of these studies analyzed a limited number of O-D pairs (*5–7*). To our knowledge the study described here is the first large-scale systematic assessment of actual trip times and reliability of rail freight car movements through the United States and Canada. As of the beginning of 1995 the study was certainly the most ambitious analysis of trip times and reliability ever attempted by the Association of American Railroads (AAR), which is the only organization with access to a complete data base on freight car movements in the United States and Canada. Individual roads have access to data only for the movements of their cars or for movements in which they participate, so they are unable to conduct a study based on truly representative samples for the entire industry. Little attempt is made herein to determine the causes of trip time variability, because discussions of causality and more detailed analyses of the car cycle data for each car type can be found in related papers (*8–10*).

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DATA SOURCE

The data were provided through AAR's Car Cycle Analysis System (CCAS), which is designed primarily for the analysis of car cycle times. A car cycle begins when a car is placed empty for loading and ends when it is again placed empty for loading. The car cycle time is composed of four basic components: shipper time (i.e., loading time), total loaded time, consignee time (i.e., unloading time), and total empty time. The shipper time begins when a car is placed empty at the shipper's siding and ends when it is released with a load. The loaded time extends from the time of release until its placement when it is loaded at the consignee's siding. The consignee time is the time from the the car's placement when it is loaded until the time that the car is unloaded and released to the railroad. The empty time is the time from the car's release when it is empty until it is again placed empty for the next shipper. The empty time can be divided into the empty trip time and the empty terminal time.

CCAS followed intermodal cars but not intermodal containers or trailers. Hence, the O-D trip time began with the time of departure from the origin ramp and ended with the time of arrival at the destination ramp. The loading and unloading time referred to the time that the intermodal cars spent being unloaded and reloaded, including any waiting time between unloading and reloading. CCAS did not include the time that containers or trailers spent in the intermodal terminal, that is, the time from arrival at the gate until the time of departure on a train and the time from arrival on a train until the time of clearing the gate.

In Figure 1 the loaded and empty trips can include movements through several yards. The loaded and empty terminal times shown in Figure 1 refer only to the time spent in the final terminal before being placed loaded or empty at the customer's siding. Each record in CCAS includes the Standard Point Location Codes (SPLC) information. For the boxcar data each record also includes the Standard Transportation Commodity Codes information. For each type of traffic car cycle data collection was done in two steps. First, a 10 percent sample of cars was randomly selected from the Universal Machine Language Equipment Register. Second, all of the car cycle records for the selected cars were extracted from CCAS for an entire year (December 1989 to November 1990 for boxcars and the following year for the others). Note that only logical car cycle records with complete information on loaded time were selected.

SELECTION OF O-D PAIRS

O-D pairs were defined by using the six-digit SPLC, which identifies locations at the station level. Defining O-D moves by shipper rather than by SPLC might have been more desirable, but shipper information was not available. For the boxcar data, however, it was found that more than 90 percent of O-D pairs had only one commodity group, which suggested that most O-D pairs corresponded to movements from one shipper to a single consignee.

For each car type trip time and reliability were evaluated for the highest-volume movements. For the boxcar and double-stack car O-D pairs that had more than 30 car moves in the 1-year sample, which corresponds to approximately 300 moves per year, were selected.

The covered hopper data included cars that moved in general merchandise trains (i.e., single-car or multicar service) as well as cars that moved in unit train service. To identify cars moving in unit train service, it was assumed that a group of car moves that had the same origin, destination, origin railroad, destination railroad, departure date from origin, and arrival date at destination moved as a single shipment. It was assumed that shipments having at least four car movements were unit train moves in the sample (approximately 40 moves in total), whereas shipments having fewer than four car movement records likely moved in carload or multicarload train service. For unit train moves the total number of shipments over the year for each service lane (i.e., for each combination of origin, destination, origin railroad, and destination railroad) was identified, and this was considered to be the number of unit train operations during the year. Service lanes that had at least 10 train operations a year were selected to represent regular unit train service.

The selection of O-D pairs and the records sampled for each car type are summarized in Table 1. It is evident that only a small per-

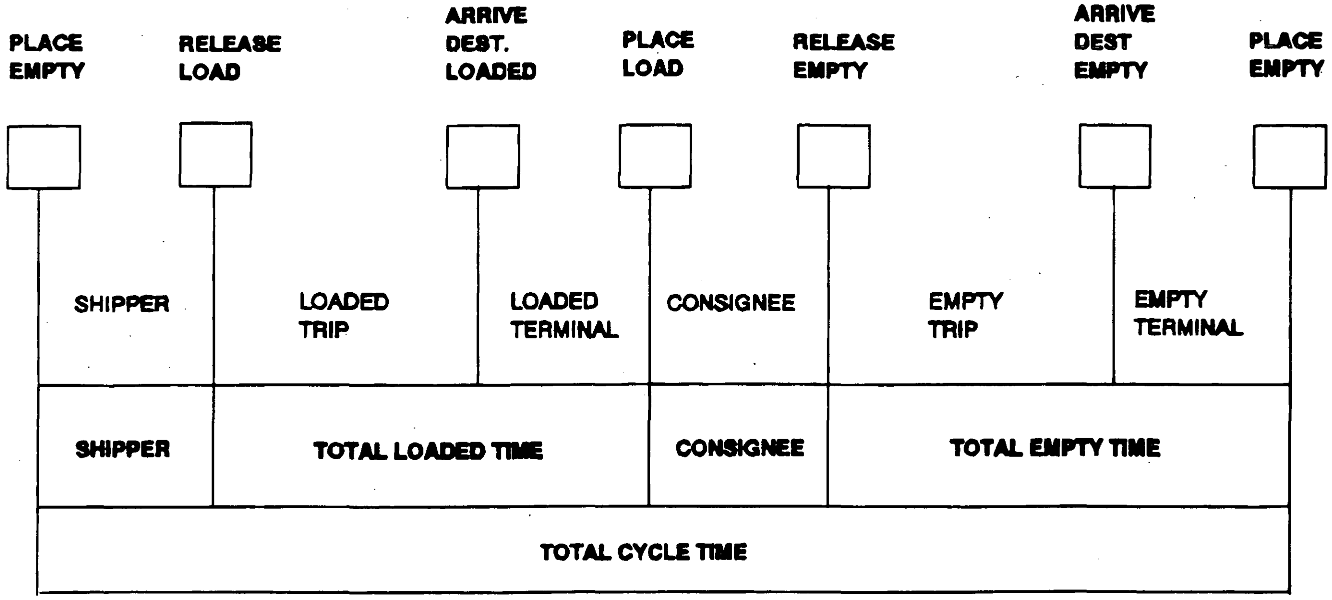


FIGURE 1 Components of car cycle.

TABLE 1 Selection of O-D Pairs

Car type	Initial Sample Size	Selected OD Pairs	Total Moves, Selected OD Pairs	Moves/O-D
Box car	252,619	477	29,120 (11.5%)	61.0
Covered hopper car	351,024	102	11,115 (3.2%)	109.0
Double-stack car	23,026	20	10,486 (45.6%)	524.3

centage of covered hopper car movements were made in regular unit train service. Also, double-stack car service was highly concentrated, with the 20 largest O-D pairs accounting for 46 percent of total double-stack car movements, whereas the 477 largest boxcar moves accounted for only 12 percent of total boxcar movements.

TRIP TIME AND RELIABILITY MEASURES

The mean trip time, standard deviation, and two other reliability measures for the selected O-D pairs were calculated. The existence of occasional very long trip times limits the usefulness of the standard deviation as a measure of the compactness of trip time distribution. Therefore, two additional measures of trip time reliability were used. The *n*-day-percent centered about the mean measures the percentage of the cars that arrive within a time window that begins n/2 days before the mean trip time and ends *n*/2 days after the mean trip time. However, since trip time distributions are often skewed to the right it is often possible to obtain a higher percentage by using a different window. The maximum *n*-day-percent is the maximum percentage of cars that arrive at the destination within any *n*-day period. For example, the maximum 2-day-percent measures the largest percentage of cars that arrived in any 48-hr time window. This measure is independent of predetermined schedules, is relatively insensitive to excessive data values or data errors, and is not highly related to the mean value.

Consider an example of O-D trip time distribution (Figure 2). The mean trip time is 5.0 days and the standard deviation of the trip time is 1.7 days. The 3-day-percent about the mean (from day 4 to day 6) is 59.6 percent. The maximum 3-day-percent (from day 3 to day 5) is 60.6 percent.

Shippers are also concerned with performance relative to schedules (or customer commitments). Because car schedule information was not available, performance for the moves in this data set relative to schedules could not be analyzed. To the extent that customer commitments include a buffer against trip time variability, performance relative to commitments can be higher than the 2-day-percent measures obtained in the present study. For example, data from a Class I railroad for their most important customers showed that 87 percent of carload trips made their commitments in April, July, and October 1991 and at the beginning of January 1992 (*9*).

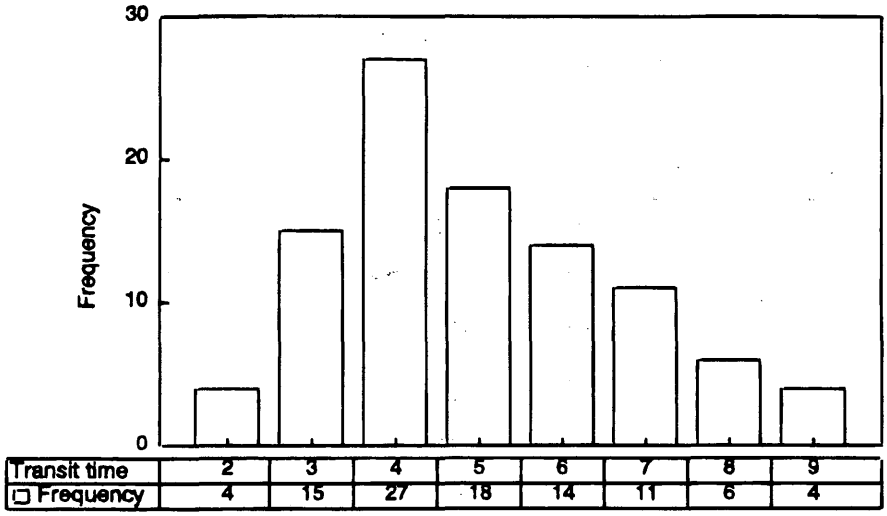
TRIP TIME AND RELIABILITY OF BOXCAR TRAFFIC

Car Cycle Time Analysis

Components of the car cycle were analyzed for the entire sample of boxcars (Table 2). The average loaded time was just under 9 days; the empty time was much longer than the loaded time largely because there was a surplus of boxcars during 1990. Table 2 also shows performance for local movements handled by a single railroad and interline movement handled by two or more railroads. Loaded and empty times of local movements were shorter than those of interline movements, but shipper and consignee times were equivalent.

Trip Time and Reliability Analysis

Trip time and reliability were analyzed for the highest-volume O-D pairs. The average loaded time of 7.2 days was nearly



Transit time	2	3	4	5	6	7	8	9
□ Frequency	4	15	27	18	14	11	6	4

FIGURE 2 Example of O-D trip time distribution.

TABLE 2 Car Cycle Time: Boxcar Service

	Total	Local	Interline
No. of moves	48,129	16,382	31,747
Shipper time	2.15 days	2.12	2.16
Loaded time	8.77	6.78	9.81
Consignee time	1.48	1.49	1.47
Empty time	14.48	12.95	15.27
Total cycle time	26.88	23.33	28.71

20 percent shorter than the overall boxcar average of 8.8 days given earlier. Since a typical boxcar spent less than 2 days moving loaded in trains given an average length of haul of 1,268 km (788 mi) and an assumed train speed of 32 kph (20 mph), the majority of time was spent in other activities, presumably in terminals. The overall reliability level of boxcar traffic was very low, because the maximum 2-day-percent of boxcar traffic was only 48.6 percent.

To examine any meaningful relationship among trip time, reliability performance, and other characteristics of O-D car movements (e.g., number of car moves, number of participating railroads, and distance) the correlation coefficients between variables were analyzed. Table 3 shows that the number of car moves (i.e., annual shipment volume), number of participating railroads (i.e., number of interchange operations), and distance had a significant correlation with trip time. O-D pairs that had longer distances, a larger number of participating railroads, or smaller volumes tended to have longer trip times. O-D pairs with longer distances or a larger number of railroads also were less reliable (measured as maximum 2-day-percent), but the correlation between the number of moves and reliability was not significant. This result is consistent with the results of a previous analysis conducted with the same data base, which showed that high-volume O-D pairs clearly had shorter trip times than low-volume O-D pairs but that they were barely reliable (*8*).

The correlation between the reliability and the mean trip time was highly significant (Table 3). Typically, railroad analysts assert that long trip times are acceptable to shippers if the reliability is good. However, no distinct cluster of O-D pairs that had both long trip time and good reliability could be found. The majority of the loaded trip time is not spent moving in a train but is spent in other activities. This suggests that the reliability of car movements can be improved by reducing the time spent in those activities or by making them more reliable.

This assertion is supported by other previous studies. Previous studies on O-D trip time performance indicated that the majority of trip time was spent in terminals (*11*). A recent study on the causes of unreliable service, based on data from a major railroad, showed that terminal and train delays accounted for more than 40 percent of the delays to shipments (*9*). That study concluded that unreliable service is more closely related to the management of resources (terminal management, train management, and power distribution) than to deficiencies in the technology or hardware of railroading.

Figure 3 shows the distribution of O-D pairs in terms of the maximum 2-day-percent. It indicates that significant performance variability exists among different O-D pairs.

Reliability performance for the combination of O-D and commodity was further identified and analyzed. Table 4 summarizes the distribution of O-D pairs and commodity groups among different ranges of reliability performance. These results indicate that a certain degree of service differentiation exists at the level of commodity groups and individual shippers. For example, 60 percent of the O-D pairs involving food or kindred products had a maximum 2-day-percent of less than 40 percent, whereas only 17 percent of the O-D pairs involving transportation equipment had a maximum 2-day-percent below 40 percent. The best service was provided to hazardous materials, which were primarily shipments of ammunition to ports during the buildup to the war in the Persian Gulf. Table 4 also shows that significant variability of performance exists among O-D pairs even in the same commodity group.

TRIP TIME AND RELIABILITY OF COVERED HOPPER CAR TRAFFIC

Car Cycle Time Analysis

Table 5 shows the cycle time components for covered hopper cars moving in unit train service. Covered hopper cars had car cycle times much shorter than those of boxcars, and all of the components of the covered hopper car cycle were shorter than those of the boxcar cycle.

TABLE 3 Correlation Coefficients Between Variables: Boxcar Service

	Mean Time	Std dev	2-day-% mean	Max. 2-day-%
No. of moves	-0.22233	-0.07619	0.08971	0.06029
	(0.0001)	(0.0965)	(0.0502)	(0.1758)
No. of railroads	0.45653	0.18144	-0.24192	-0.30515
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Distance	0.63421	-0.08251	-0.04399	-0.15649
	(0.0001)	(0.1408)	(0.4330)	(0.0050)
Mean trip time		0.66655	-0.55654	-0.61875
		(0.0001)	(0.0001)	(0.0001)

( ) is the probability that a null hypothesis H_0: $\rho=0$ can be rejected

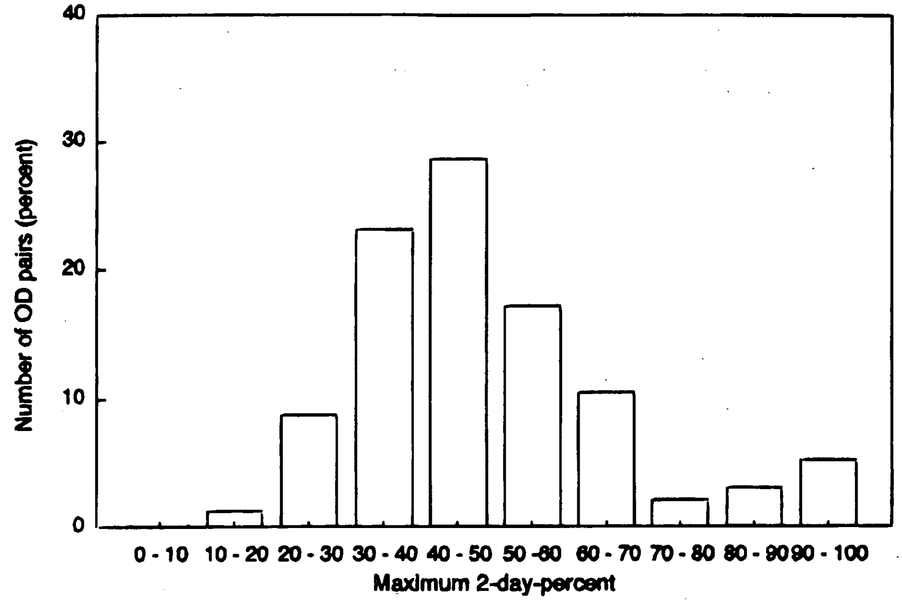


FIGURE 3 Distribution of O-D pairs among different ranges of reliability performance: boxcar service.

Once again local movements had shorter car cycles than interline movements. Local movements were shorter for each component of the car cycle except shipper time. Since the number of cars moving in regular unit train service was so small, the average car cycle components were also determined for the entire sample of covered hoppers. The results were very similar to the results for boxcars: the average loaded time was 9.0 days and the total cycle time was 24.1 days.

Trip Time and Reliability Analysis

The distance of a typical O-D pair of covered hopper car traffic was 1,337 km (831 mi) and the average trip time was 5.2 days. The reliability of covered hopper car moves was higher than that of the boxcar moves. The maximum 2-day-percent of covered hopper cars was 60.9 percent. Because cars moved by unit trains are generally not reclassified in intermediate terminals, the loaded trip time consists of the train's travel time plus the time in the origin and destination terminals. Trip time and reliability are therefore closely related to how a railroad prioritizes unit trains in meet/pass planning and in assigning crews and power. Another factor in the variability of unit train trip times is that some railroads hold groups of 40 or more cars at a terminal for several days until they can be combined with similar groups to form a unit train.

A correlation analysis showed that the number of participating railroads and distance had a significant linear relationship with the mean trip time (Table 6). The results showed that the reliability deteriorated for O-D pairs with longer distance and mean trip time.

TABLE 4 Distribution of O-D and Commodity Groups among Different Ranges of Reliability Performance

	Maximum 2-day-percent				
Commodity	0-20	20-40	40-60	60-80	80-100
Farm products	-	6 (54.5)	3 (27.3)	-	2 (18.2)
Food or kindred products	-	9 (60.0)	4 (26.7)	2 (13.3)	
Lumber or wood products	-	3 (23.1)	6 (46.2)	1 (7.7)	3 (23.0)
Pulp and paper	1 (0.8)	45(34.4)	66(50.4)	13(9.9)	6 (4.5)
Chemicals	-	2 (40.0)	1 (20.0)	2 (40.0)	-
Rubber or plastic products	-	1 (12.5)	5 (62.5)	2 (25.0)	-
Clay, concrete, glass, stone	-	2 (20.0)	7 (70.0)	1 (10.0)	-
Primary metal products	-	1 (12.5)	3 (37.5)	4 (50.0)	-
Electrical machinery	1 (7.1)	4 (28.6)	4 (28.6)	4 (28.6)	1 (7.1)
Transportation equipment	-	25(17.4)	85(59.0)	31(21.5)	3 (2.1)
Waste and scrap	-	2 (33.3)	4 (66.7)	-	-
Hazardous materials	-	-	-	3 (16.7)	15(83.3)

( ) is the percentage of O-D pairs

TABLE 5 Car Cycle Time: Covered Hopper Car Service

	Total	Local	Interline
No. of moves	6,799	5,397	1,402
Shipper time	1.92 days	2.04 days	1.46 days
Loaded time	5.33	5.19	5.85
Consignee time	1.27	1.19	1.57
Empty time	6.76	6.35	8.34
Total cycle time	15.27	14.77	17.23

The correlations between the number of car moves or the number of railroads and reliability were not significant. The correlation between the reliability and the mean trip time was again highly significant. In fact, covered hopper car service had an even stronger linear relationship between the reliability and the mean trip time ($\rho = -0.77$ versus -0.62 for the boxcar service).

The analysis indicates that significant performance variability exists among different O-D pairs. Figure 4 shows the distribution of O-D pairs of covered hopper car traffic among different ranges of maximum 2-day-percent.

TRIP TIME AND RELIABILITY OF DOUBLE-STACK CAR TRAFFIC

Car Cycle Time Analysis

Components of the car cycle were analyzed for the entire sample of double-stack cars (Table 7). More than half of double-stack car moves (51.2 percent) had less than 1 day of empty time, and both the loading and unloading times were well under 1 day. Overall, the double-stack car cycle was less than half of the covered hopper car cycle and only a third of the boxcar cycle. For double-stack car movement the empty time was shorter than the loaded time. For this traffic the empty time is usually incurred within the terminal area, because the double-stack cars are generally reloaded rather than moved empty to another terminal. Local movements again had shorter car cycle times than interline movements.

Trip Time and Reliability Analysis

The trip time and reliability performance of double-stack car movements by unit train service were analyzed for each selected corridor. The average loaded time was 2.5 days, which is much faster service than that with boxcars or covered hopper car unit trains. The reliability of double-stack car service was also much higher. The maximum 1-day-percent of double-stack car traffic was 89.2 percent, which means that 9 of 10 cars consistently arrived within a 1-day window; the maximum 8-hr-percent was 62.4 percent, which is probably a better indication of reliability for this traffic. It should be noted that seasonal or other changes in train schedules would have a much greater effect on double-stack train service than on either of the other services. The degree of reliability of double-stack car service for a shorter period would be higher than the 12-month averages described in this section.

To examine the relationship between the characteristics of intermodal traffic movements and performance, double-stack car movement was classified into eastbound and westbound movements (Table 8). It was also classified into long- and short-distance movements, with long distance defined as longer than 2,414 km (1,500 mi). Although westbound movements had slightly shorter trip times than eastbound movements, no significant differences in reliability were found between the two directions. Short-distance movements were both faster and more reliable than the long-distance movements.

In some cases the trip time and reliability varied greatly among different carriers. In the example depicted in Table 9 the maximum 1-day-percent ranged from 39 to 99 percent. Some significant differences in reliability also occurred between eastbound and westbound movements at the corridor or carrier level.

SUMMARY AND CONCLUSIONS

Table 10 summarizes and compares the car cycle time for the three services. The average car cycle time and all components of the car cycle time were longer for boxcar traffic than for the other types of traffic. The average boxcar cycle was almost 4 weeks, nearly double the cycle for covered hoppers moving in unit trains and four times as long as the 6-day cycle time for double-stack cars.

TABLE 6 Correlation Coefficients Between Explanatory Variables and Reliability: Covered Hopper Car Unit Train Service

	Mean Time	Std dev	2-day-% mean	Max. 2-day-%
No. of moves	-0.01559	0.03673	-0.01632	-0.10494
	(0.8764)	(0.7140)	(0.8707)	(0.2939)
No. of railroads	0.21154	-0.08271	-0.05291	-0.09068
	(0.0328)	(0.4085)	(0.5974)	(0.3647)
Distance	0.61274	0.17274	-0.37354	-0.35955
	(0.0001)	(0.1139)	(0.0004)	(0.0007)
Mean trip time	-	0.73639	-0.70767	-0.77366
		(0.0001)	(0.0001)	(0.0001)

( ) is the probability that a null hypothesis H_0 : $\rho=0$ can be rejected

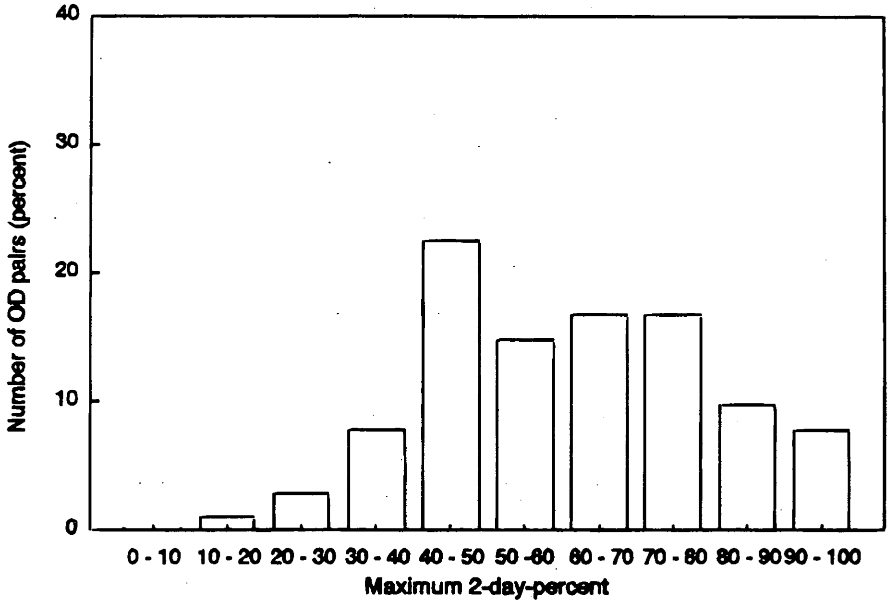


FIGURE 4 Distribution of O-D pairs among different ranges of reliability performance: covered hopper car unit train service

Clear differences in the trip times and reliabilities of the three different services were also found (Table 11). The service provided to boxcar traffic was significantly slower and less reliable than that provided to the other types of traffic. The maximum 2-day-percent for a typical boxcar movement was just under 50 percent, which is evidence of substantial variability in the level of service provided to general merchandise shippers. On the other hand the ramp-to-ramp service provided to double-stack cars was significantly faster and more reliable than that provided to the other two types of traffic. The maximum 1-day-percent for a typical double-stack car movement was just under 90 percent; the 8-hr-percent was more than 60 percent.

Finally, considerable variations in service levels among different O-D pairs for each train service were found. It was not clear, however, if such differentiated service levels were the result of intended efforts to differentiate service considering the service requirements of individual O-D pairs or if they simply reflected differences inherent in the operating plan, reactions to daily traffic variability, or other factors. To understand the causes of such dif-

TABLE 7 Cycle Time for Double-Stack Cars

	Total	Local	Interline
No. of moves	2,573	1,804	769
Shipper time	0.73 days	0.73	0.72
Loaded time	3.21	2.59	4.67
Consignee time	0.22	0.21	0.26
Empty time	1.99	1.82	2.38
Total cycle time	6.15	5.35	8.04

TABLE 8 Trip Time and Reliability Performance by Direction and Distance: Double-Stack Car Service

		Eastbound			Westbound	
	Total	Long	Short	Total	Long	Short
Total number of moves	4,387	3,721	666	5,873	4,287	1,586
Distance	n/a	n/a	n/a	n/a	n/a	n/a
Mean trip time	64.4 hr.	70.8	28.6	58.0	67.4	32.8
Std dev of trip time	11.2 hr.	10.9	12.7	12.4	10.7	16.9
Maximum 8-hour-%	61.2 %	60.2	66.7	63.3	59.3	74.1
Maximum 12-hour-%	72.8 %	72.2	76.7	75.1	70.4	88.1
Maximum 24-hour-%	89.4 %	88.7	93.3	89.0	86.3	96.5

Source : (*10*)

TABLE 9 Trip Time and Reliability of Different Carriers: Double-Stack Car Service

Carrier	K		L		M	
Direction	E/B	W/B	E/B	W/B	E/B	W/B
Distance	n/a	n/a	n/a	n/a	n/a	n/a
Mean trip time	66.0 hr.	71.4	39.4	38.0	99.4	82.7
Std dev of trip time	4.9 hr.	16.4	7.6	7.7	25.1	22.4
Maximum 8-hour-%	66.7 %	56.3	46.3	63.5	16.6	22.1
Maximum 12-hour-%	83.9 %	65.6	60.6	73.9	23.0	32.2
Maximum 24-hour-%	98.9 %	86.5	86.9	93.2	38.8	58.9

Source : (*10*)

TABLE 10 Car Cycle Time for Different Train Services

	Boxcar	Covered hopper	Double-stack
Loading time	2.15 days	1.92	0.73
Loaded time	8.77	5.33	3.21
Unloading time	1.48	1.27	0.22
Empty time	14.48	6.76	1.99
Total cycle time	26.88	15.27	6.15

TABLE 11 Trip Time and Reliability Performance of Different Train Services

	Boxcar	Hopper car	Double-stack
OD Pairs	477	102	20
Number of Railroads	2.11	1.47	n/a
Distance	788.1 miles	831.0	n/a
Mean trip time	7.16 days	5.25	2.53
Std dev of trip time	2.62 days	2.04	0.50
Maximum 1-day-%	32.42 %	41.90	89.2
Maximum 2-day-%	48.56 %	60.95	n/a
Maximum 3-day-%	61.07 %	73.21	n/a

ferentiated service levels additional information on the shippers' service expectations, the carriers' operating policies, the competition among railroads, and the competition between rail and truck services would be needed.

The car cycle times and the O-D performance presented in this paper can be interpreted as describing typical rail freight service in the United States and Canada in 1990 and 1991. These measures can also be used as benchmarks for evaluating ongoing efforts to improve car use and freight service reliability.

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