

effect and opportunity associated with service-route minimization; however, the effect is small compared with the opportunities to minimize empty-car miles by repositioning cars so as to maximize reload opportunities.

#### CONCLUSION

A study has been presented of the loaded flow, empty-car supply and demand, and opportunities for car-mile minimization by empty-car repositioning for a variety of car type and commodity combinations. The analysis is entirely quantitative and suggests that although there is a sizeable skewness in the supply and demand for specific equipment types, the degree of skewness varies greatly. This suggests good opportunities for finding backhauls, thus reducing empty-car miles, which was unexpected for some equipment types. The analysis suffers only slightly from studying only spatial skewness without temporal effects. The temporal or seasonal effects can be minimized in a period of large surpluses in equipment by maintaining proper strategic inventories of the surplus cars so that temporal imbalances can be smoothed. Minimizing empty-car miles can add to the surplus, which should lead to further smoothing of any temporal imbalances.

Significant further research and analysis needs to be carried out. The optimal empty-car flow needs to be compared with the actual flow. The difficulty is that there exists no publicly accessible data source on empty-car movements. Nevertheless, railroad companies, shippers, and car owners do (or should) maintain proprietary data bases on these movements. Those companies that do have access to these data sources should utilize the MTOPT methodology to analyze opportunities for improved car management.

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## Measuring the Quality of Freight Service: Analysis of Shipper Recording Practices with Emphasis on Railway Users

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The purpose of the study was to determine the extent to which quality of freight service is measured and recorded by transportation buyers. To be specific, a mail questionnaire was sent to a sample of traffic managers to assess their recording behavior with respect to 22 quality-of-service attributes. Overall, the results indicate that although service measurement generally does take place, it tends to be accomplished on an informal basis rather than through formally recorded reports. Likewise the results indicate that recording practices do differ somewhat, depending on the degree of rail use by the shipper. Some managerial implications of these results for both buyers (i.e., shippers or users) and sellers (i.e., carriers) of freight service are presented.

In every industry, attention must be given to customer needs and preferences, or what is commonly referred to as the marketing concept (1, pp. 22-25). For the rail and trucking industries, this attention takes an increased significance as both industries move toward a more competitive environment spurred by regulatory relaxation and greater economic pressures.

The significance of researching the shipper's transport selection decision is great. In the long run, product and pricing strategy is based on knowledge of the mode and carrier characteristics rated highly by shippers. Over shorter time horizons, the carrier wants to identify shippers with similar needs or preferences. In this way sales resources can be allocated more efficiently and sales ap-

proaches or strategies can be planned more effectively.

Research regarding the transportation selection decision is important also to the buyer of transport services. The responsibility for so-called right and wrong transport selection decisions generally rests with the traffic manager, and the results of such decisions can mean the difference of hundreds of thousands of dollars to a company. Whatever traffic managers can do to make themselves better informed and educated consumers is obviously to their advantage.

Over the past decade, the transport selection decision has been the subject of numerous survey analyses. It is not our intention to review these surveys in detail, since this has been done previously (2, pp. 5-9). It is relevant, however, to note in passing that these studies vary in technique, objective, and, in many cases, conclusions (3-10). Generally, these studies are characterized as follows:

1. Some studies analyze the importance of various quality-of-service attributes or factors solely for the mode selection decision. Other studies analyze only the carrier selection decision. Others look solely at the private versus for-hire decision. Some studies analyze two or more of the

preceding decisions, and some studies do not distinguish as to the type of transport decision (e.g., modal, carrier, for-hire) being investigated.

2. Some studies contrast importance ratings between buyers (i.e., shippers), types of buyers, and sellers (i.e., carriers). Significant differences in ratings suggest remedial policies for the carrier.

3. Past studies, to varying degrees, differentiate importance ratings by characteristics of the decision maker, the commodity, the firm's traffic pattern, the firm's distribution organization and competitive environment, use patterns, and other demographic variables.

In summary, most selection criteria studies to date have attempted to identify and analyze the importance of various factors that traffic managers consider when arriving at a modal or carrier choice. What has been virtually ignored by these studies is the measurement aspects of service quality. For example, do shippers keep records of the service quality and performance of carriers with regard to key selection variables? If so, to what extent and for which variables?

In other words, it is simply not enough to identify and determine the importance of various selection variables or factors. Specific measures and techniques for recording the quality of service associated with these variables are also necessary for making effective transport purchase decisions.

#### PURPOSE AND METHODOLOGY

The purpose of this paper is to determine the extent to which quality of service is currently measured or recorded by transport buyers. More specifically, the paper examines the following questions:

1. To what extent are quality-of-service factors formally recorded or measured by shippers?
2. To what extent are quality-of-service factors recorded or not recorded by shippers?
3. To what extent do recording practices differ by degree of railway use?

4. To what extent do recording practices differ between all shipper respondents and high-use rail shippers?

It is important to note that the scope of the paper is limited to examining the extent to which quality-of-service measurement or recording takes place and not the specific measures being recorded. The latter topic will be addressed in a separate paper. Likewise, in this paper we do not address the question of measurement differences based on demographic variables with the exception of degree of rail use, as mentioned above.

An important prerequisite of the study was to identify the quality-of-service factors that act as important determinants of transport selection. From a review of the literature, 22 factors were identified. Overall quality of service was defined to be a function of these factors. For classification purposes, the factors were grouped arbitrarily into seven categories of factors: rate-related, operations-related, people-related, time-related, claims-related, equipment-related, and miscellaneous. The 22 factors and group designations are presented in Table 1.

To obtain the required information, mail questionnaires were sent to 1,000 traffic and distribution managers selected randomly (11). Nondeliverable questionnaires ultimately reduced this number to 908. Of this number, 202 usable questionnaires were returned; the response rate was approximately 23 percent. Given the length and detail of the questionnaire, this response rate was regarded as good and more than adequate for analysis purposes. Likewise the respondents were judged, based on demographic characteristics, to be highly representative of a wide variety of shipper organizations and traffic executives.

The survey instrument was a very detailed two-part, five-page questionnaire. Part 1 requested information on the importance of the 22 carrier or mode quality-of-service attributes and demographic information about the decision maker, the company,

Table 1. Measurement of quality-of-service factors by all shipper respondents.

Quality-of-Service Factor	Category Designation <sup>a</sup>	Percentage of Respondents Indicating Factors as			Total Recorded <sup>b</sup> (%)
		Recorded Formally	Recorded Informally	Not Recorded	
Door-to-door transportation rates or costs	R	45.0	36.3	18.7	81.3
Freight loss and damage experience	C	43.4	35.3	21.3	78.7
Claims-processing experience	C	39.8	35.5	24.7	75.3
Transit-time reliability or consistency	T	30.9	47.4	21.7	78.3
Experience with carrier in negotiating rate changes	R	27.3	41.2	21.5	68.5
Shipment tracing	O	26.7	44.2	29.1	70.9
Total door-to-door transit time	T	23.8	44.2	32.0	68.0
Quality of pick-up and delivery service	O	22.8	41.4	35.8	64.2
Availability of single-line service to key points in shipper's market area	O	22.4	41.2	36.4	63.6
Equipment availability at shipment date	E	21.1	47.6	31.3	68.7
Shipment expediting	O	18.6	49.7	31.7	68.3
Experience with carrier in negotiating service changes	O	17.0	43.6	39.4	60.6
Specialized equipment to meet shipper needs	E	16.8	36.5	46.7	53.3
Frequency of service to key points in shipper's market area	O	15.6	46.1	38.3	61.7
Physical condition of equipment	E	12.7	37.0	50.3	49.7
In-transit privileges	O	11.9	27.1	61.0	39.0
Diversion or reconsignment privileges	O	11.2	22.8	66.0	34.0
Quality of operating personnel	P	5.6	42.8	51.6	48.4
Carrier image or reputation	M	3.1	41.4	55.6	44.5
Reciprocity	M	2.6	23.2	74.2	25.8
Quality of carrier salesmanship	P	2.5	32.9	64.6	35.4
Gifts and gratuities offered by carrier	M	2.0	13.0	85.0	15.0

<sup>a</sup>R = rate-related factor; T = time-related factor; C = claims-related factor; E = equipment-related factor; P = people-related factor; O = operations-related factor; and M = miscellaneous factor.

<sup>b</sup>Represents the sum of percentages indicated for formally and informally recorded.

traffic characteristics, and transportation use patterns. In part 2, the questionnaire sought information regarding the extent to which the quality-of-service factors were measured or recorded. Pre-testing had indicated that there are generally three levels of recording: formal, informal, and none. (These levels are analogous, in a sense, to precise measurement, imprecise measurement, and no measurement.) Distinctions among these levels are as follows:

1. Formal recording: There exists a systematic procedure for written recording of data relating to the quality-of-service factor.

2. Informal recording: Data relating to the factor are noted or recorded, but no systematic procedure has been established for doing so. Recording may be either written or unwritten.

3. No recording: Data relating to the factor are not recorded.

To be specific, for each of the 22 factors, respondents were asked to indicate whether the factor is recorded formally, informally, or not at all when the quality of freight service is measured. The recording information collected in part 2 of this survey was used as the basis for this paper.

#### SURVEY FINDINGS

##### Recording Practices of All Shipper Respondents

Table 1 indicates the extent of measurement with respect to the 22 quality-of-service factors. These factors are ranked from high to low depending on the percentage of respondents indicating formal recording or measurement of a given factor.

Overall, it appears that most quality-of-service measurement takes place on an informal basis and not through formally recorded reports. Only six of the factors were formally recorded by as many as one in four (i.e., 25 percent) of respondents. These factors were as follows: door-to-door transportation rates or costs, freight loss and damage experience, claims-processing experience, transit-time reliability or consistency, experience with carrier in negotiating rate changes, and shipment tracing. With one exception, these factors tended to be related to rates, claims, or time.

At the other extreme, five of the factors were not formally recorded by as many as 1 in 10 respondents (i.e., 10 percent). These included gifts and gratuities offered by carrier, quality of carrier salesmanship, reciprocity, carrier image or reputation, and quality of operating personnel. All of these factors tended to be in the people-related and miscellaneous categories. The remaining factors in Table 1 were recorded formally by between 10 and 25 percent of the shipper respondents.

Thus it appears that relatively few factors are recorded formally to any degree. In effect, we witness the Pareto principle, in which a small percentage of the factors accounts for a disproportionately large percentage of the formal recording. Higher percentages were indicated for formal recording than for informal recording for only three factors--door-to-door transportation rates or costs, freight loss and damage experience, and claims-processing experience. In all other cases, the quality-of-service factors were more likely to be recorded informally.

It is interesting to note that the factors with the highest formal recording percentages generally are similar to those shown to be most important in previous carrier- or mode-selection studies. This is especially true with respect to transportation rates and transit-time reliability. Given the cost

and time associated with developing a formal recording system, it makes sense that only the most important factors warrant systematic written recording. At the same time, it should be noted that certain traffic activities by their very nature require more formalized recordkeeping. For example, the successful handling of claims requires necessary support documentation. The same can be said for rate negotiation and tracing activities, among others. Undoubtedly this fact helps explain the relatively high level of formal recording with respect to some factors.

A mild surprise from the study was the low level of formalized recording in the area of people-related factors, such as quality of carrier salesmanship and quality of operating personnel (e.g., drivers). It would appear that this would be a major area of contact between carrier and shipper organizations and hence deserving of formal recording. However, this was not the case. What appears to be happening is that these people-related factors are receiving much more in the way of informal recording (see Table 1).

It is also interesting to note the relatively high extent of recording currently taking place with regard to experience with the carrier in negotiating rate changes. In the future this figure can be expected to increase as efforts are made by more companies to emphasize negotiations and bargaining to take advantage of greater pricing flexibility under deregulation.

Finally, the results show that, for a majority of the quality-of-service factors studied, measurement was more likely to take place than not. This can be seen in Table 1 in the column headed Total Recorded. Overall recording was more likely to take place with respect to the factors related to rates, claims, time, and equipment.

##### Recording Practices Based on Rail Use

Although there are many demographics that could be examined in conjunction with recording practices, it was decided to analyze differences in recording practices based on the degree of railway use by shippers.

The demographic information was gathered in the survey by asking shippers to estimate the percentage of their unit's freight tonnage that regularly moves by each transportation alternative. For rail, the breakdown was as follows:

<u>Percentage of Tonnage Shipped by Rail</u>	<u>No. of Shippers</u>	<u>Percentage of Total Shippers</u>
0-10	107	53.0
11-20	13	6.4
21-30	8	4.0
31-40	9	4.4
41-50	4	2.0
51-75	19	9.4
76-100	42	20.8
	202	

Based on this breakdown, a decision was made to classify shippers into the following categories for analysis purposes: low use, 0-10 percent; moderate use, 11-50 percent; and high use, 51-100 percent. The resulting analysis is shown in Table 2.

In general, the results are similar to those identified in Table 1. Again relatively few factors are formally recorded to any great extent, and recording (whether it be formal or informal) is more likely to take place than not.

With respect to categories of use, five factors with statistically significant recording differences were identified. In general, these factors tended

Table 2. Recording practices based on degree of railway use.

Quality-of-Service Factor	Category Designation <sup>a</sup>	Rail Use by Percentage of Tonnage Shipped								
		High (51-100 percent)			Moderate (11-50 percent)			Low (0-10 percent)		
		F <sup>b</sup>	I <sup>c</sup>	N <sup>d</sup>	F	I	N	F	I	N
Door-to-door transportation rates or costs	R	53.6	26.8	19.6	48.1	29.7	22.2	44.4	38.6	17.0
Claims-processing experience	C	44.3	28.8	26.9	42.9	35.7	21.4	36.0	39.5	24.4
Freight loss and damage experience	C	42.6	31.5	25.9	50.0	25.0	25.0	41.7	40.7	17.6
Experience with carrier in negotiating rate changes	R	37.0	35.2	27.8	17.7	43.8	38.5	27.0	41.2	31.8
Transit-time reliability or consistency	T	34.5	40.0	25.5	32.1	42.9	25.0	28.2	53.3	18.5
Shipment tracing	O	27.8	44.4	27.8	14.2	42.9	42.9	30.0	44.4	25.6
Quality of pick-up and delivery service	O	25.5	25.5	49.0	8.0	44.0	48.0	24.7	50.6	24.7 <sup>e</sup>
Total door-to-door transit time	T	24.1	44.4	31.5	28.6	32.1	39.3	22.2	47.8	30.0
In-transit privileges	O	24.1	29.6	46.3	4.0	20.0	76.0	6.2	27.5	66.3 <sup>e</sup>
Equipment availability at shipment date	E	23.6	49.1	27.3	7.7	57.7	34.6	23.6	43.5	32.9
Availability of single-line service to key points in shipper's market area	O	22.2	35.2	42.6	25.0	42.9	32.1	21.6	44.3	34.1
Shipment expediting	O	20.7	29.1	30.2	14.3	46.4	39.3	18.6	51.2	30.2
Specialized equipment to meet shipper needs	E	20.0	36.4	43.6	7.5	48.1	44.4	17.7	32.9	49.4
Experience with carrier in negotiating service changes	O	19.3	44.2	36.5	11.5	42.3	46.2	17.2	43.7	39.1
Frequency of service to key points in shipper's market area	O	15.5	38.5	46.2	17.8	42.9	39.3	15.0	51.7	33.3
Diversion or reconsignment privileges	O	14.8	31.5	53.7	3.7	18.5	77.8	11.1	18.5	70.4 <sup>f</sup>
Physical condition of equipment	E	11.5	48.1	40.4	7.7	19.2	73.1	15.0	35.6	49.4 <sup>f</sup>
Quality of operating personnel	P	5.8	32.7	61.5	0	46.2	53.8	7.2	48.2	44.6
Carrier image or reputation	M	5.7	30.8	63.5	0	34.6	65.4	2.4	50.0	47.6 <sup>f</sup>
Reciprocity	M	4.0	18.0	78.0	0	23.1	76.9	2.6	26.7	70.7
Quality of carrier salesmanship	P	2.0	23.5	74.5	0	30.8	69.2	3.6	39.3	57.1
Gifts and gratuities offered by carrier	M	2.0	12.0	86.0	0	7.7	92.3	2.6	15.6	81.8

<sup>a</sup>R = rate-related factor; T = time-related factor; C = claims-related factor; E = equipment-related factor; P = people-related factor; O = operations-related factor; and M = miscellaneous factor.

<sup>b</sup>Percentage of group indicating the factor as recorded formally.

<sup>c</sup>Percentage of group indicating the factor as recorded informally.

<sup>d</sup>Percentage of group indicating the factor as not recorded.

<sup>e</sup>Statistically significant at the 0.10 level or less by using a chi-square test.

<sup>f</sup>Statistically significant at the 0.05 level or less by using a chi-square test.

to be related to operations and equipment. The factors are indicated in Table 2 and include in-transit privileges, diversion or reconsignment privileges, physical condition of equipment, quality of pick-up and delivery service, and carrier image or reputation. The high-use group indicated greater overall recording for the first three factors, whereas the low-use group indicated greater recording for the last two factors.

These differences can be largely attributed to the basic nature of rail operations. For example, in-transit privileges and diversion or reconsignment are likely to be more relevant in connection with rail use than with other modes. The same can be said for the physical condition of the equipment, an area in which rail shippers typically have experienced more problems. Likewise, quality pick-up and delivery service would tend to be more important to less-than-carload-lot, air, and truck shippers as opposed to large-volume rail shippers. Finally, given the relatively small number of rail carriers in a given geographical area compared with the number of motor carriers, one would not expect carrier image or reputation to be as relevant in the transport purchase decisions of rail-oriented shippers.

#### Recording Practices of All Respondents Versus Those of High-Use Rail Shippers

A final comparison that leads to some interesting observations is shown in Table 3. Here the recording practices of all shipper respondents and high-use shippers were compared. The relevant figures in Tables 1 and 2 relating to formal and informal recording were added together to arrive at the total recorded figures shown in Table 3. It was hoped that this analysis would identify factors for which there was a noticeable difference in recording practices.

There was a 10 percent or greater difference

found between the responses of the groups for six factors, namely, physical condition of equipment, in-transit privileges, diversion or reconsignment privileges, quality of pick-up and delivery service, quality of operating personnel, and quality of carrier salesmanship. The first three factors were indicated as being more often recorded by the high-use rail shippers, whereas the latter three were indicated as being more often recorded by the total-respondent group.

For the most part, these factors are the same as those identified previously in the analysis by degree of rail use. The major exceptions pertain to the people-related factors--quality of carrier salesmanship and quality of operating personnel. Again the explanation most likely rests with the nature of rail operations compared with other modes and the resultant fact that rail-oriented shippers typically have less personal contact with carrier personnel in day-to-day operations than is true, for example, of truck-oriented shippers.

A final observation that should be made is that although a number of noticeable differences in recording practices were found, these differences for the most part involved factors that tended to receive relatively little overall recording. In contrast, there were very little in the way of differences in recording practices involving factors that tended to be recorded often (see Table 3). This leads to the conclusion that there is considerable agreement as to the factors deserving greatest measurement and the level or extent of that measurement.

#### MANAGERIAL IMPLICATIONS

These results should prove useful to traffic and carrier managers alike. The data should prove valuable to traffic and distribution managers by indicating what their contemporaries are doing currently in the area of measurement and recording. In this

Table 3. Recording practices of all shipper respondents versus high-use shippers.

Quality-of-Service Factor	Category Designation <sup>a</sup>	Percentage of All Respondents		Percentage of High-Use Rail Shippers	
		Total Recorded <sup>b</sup>	Not Recorded <sup>c</sup>	Total Recorded	Not Recorded
Door-to-door transportation rates or costs	R	81.3	18.7	80.4	19.6
Freight loss and damage experience	C	78.7	21.3	74.1	25.9
Transit-time reliability or consistency	T	78.3	21.7	74.1	25.5
Claims-processing experience	C	75.3	24.7	73.1	26.9
Shipment tracing	O	70.9	29.1	72.2	27.8
Equipment availability at shipment date	E	68.7	31.3	72.7	27.3
Experience with carrier in negotiating rate changes	R	68.5	31.5	72.2	27.8
Shipment expediting	O	68.3	31.7	69.8	30.2
Total door-to-door transit time	T	68.0	32.0	68.5	31.5
Quality of pick-up and delivery service	O	64.2	35.8	51.0	49.0 <sup>d</sup>
Availability of single-line service to key points in shipper's market area	O	63.6	36.4	57.4	42.6
Frequency of service to key points in shipper's market area	O	61.7	38.3	53.8	46.2
Experience with carrier in negotiating service changes	O	60.6	39.4	63.5	36.5
Specialized equipment to meet shipper needs	E	53.3	46.7	56.4	43.6
Physical condition of equipment	E	49.7	50.3	59.6	40.4 <sup>d</sup>
Quality of operating personnel	P	48.4	51.6	38.5	61.5 <sup>d</sup>
Carrier image or reputation	M	44.5	55.6	36.5	63.5
In-transit privileges	O	39.0	61.0	53.7	46.3 <sup>d</sup>
Quality of carrier salesmanship	P	35.4	64.6	25.5	74.5 <sup>d</sup>
Diversion or reconsignment privileges	O	34.0	66.0	46.3	53.7 <sup>d</sup>
Reciprocity	M	25.8	74.2	22.0	78.0
Gifts and gratuities offered by carrier	M	15.0	85.0	14.0	86.0

<sup>a</sup>R = rate-related factor; T = time-related factor; C = claims-related factor; E = equipment-related factor; P = people-related factor; O = operations-related factor; and M = miscellaneous factor.

<sup>b</sup>Percentage of group indicating the factor to be recorded either formally or informally.

<sup>c</sup>Percentage of group indicating the factor as not recorded.

<sup>d</sup>Factors for which there was a 10 percent or greater difference between the overall respondents and high-use rail shippers.

way comparisons can be made to determine whether or not a firm's recording system is above or below the standards indicated. It is hoped that measurement areas for further study and improvement will be indicated by this study.

In turn the findings also have meaning for carrier management. For example, the survey indicates the factors for which shippers are making the greatest efforts to measure and record quality of service. Certainly these should be areas in which special attention is paid by carriers to service and performance. The reason for this is that deviations in performance in these areas are much more likely to be detected. This detection ultimately may result in the traffic manager's switching to another carrier or mode. In contrast, it appears possible to have greater service and performance variability with respect to informally recorded or nonrecorded factors because such variability is less likely to be detected or remembered.

An additional interesting possibility is for the carrier to formally record some of these data (e.g., transit-time reliability, door-to-door transit time) with regard to a specific company's shipments and to present summaries to the traffic manager on a monthly or quarterly basis. This information itself might be used as a powerful competitive selling tool by the carrier.

In conclusion, both shippers and carriers have an important stake in quality-of-service measurement. For shippers, measurement and recording permits greater sophistication in modal and carrier selection. For carriers, measurement feedback can represent an important diagnostic technique for planning and implementing future service offerings. For both, measurement and recording can be a useful tool for the dynamic management needed in today's highly competitive environment.

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