Value of Commercial Motor Vehicle Time Saved

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The purpose of this paper is to explore the possibilities of determining reliable estimates of the dollar value that would accrue to commercial motor vehicle operators as a result of time savings occurring through use of improved highway facilities.

The estimates of the value of time developed in this report may possibly be compared and contrasted with the estimates of the value of time included in the final report of the Highway Cost Allocation Study. It was believed that a study of alternative approaches to the general problem and the development of estimates of the value of time saved to commercial truck operators in the Southwest would either (a) lend more credence to those values included in the cost allocation study; or (b) perhaps furnish evidence that more detailed studies would be desirable.

Any information developed by this study will supplement the several previous studies of vehicular travel time and fuel consumption rates under various operating conditions. The main purpose of these studies has been to provide reliable information for use in determining the benefits accruing to the users of the Federal Aid Highway System.

• DURING the early stage of this study, the decision was made to concentrate on determination of the value of time saved by commercial truck and bus operators in their intercity and over-the-road operations. It was felt that the local pickup and delivery operations of the commercial freight carriers were seldom benefited to any great extent by the urban freeway systems. Undoubtedly there are specific instances where urban arterial improvements are beneficial to the local carriers; however, the very nature of the pickup and delivery operations precludes any large usage of the urban freeways.

Records of the ICC regulated motor common carrier expenses and operating statistics were obtained for the years 1959 and 1960. These data were obtained from the report, "Transport Statistics in the United States, Part 7, Motor Carriers," which is compiled by the Interstate Commerce Commission from the annual reports of individual carriers and from an analysis of Class I and Class II motor carriers' reports, as published by Trinc Associates Ltd. These combined sources of data permitted a detailed analysis of the operations for the two-year period.

The data relating to the operating expenses and statistics of the intrastate carriers were obtained from the records on file at the Texas Railroad Commission. These records were verified, on a test basis, by mail questionnaires. The expense information for this group of carriers was for the year 1960. A limited check indicated that there were no significant differences in the expense relationships between the years 1959, 1960, and 1961.

As mentioned previously, one of the objectives of this study was to evaluate different methods of estimating the value of time to the commercial operators. Several alternative approaches were considered and their respective merits and disadvantages com-

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pared. The following general methods received the most attention: (a) toll road approach, (b) specific point-to-point movement approach, (c) area of influence of market area approach, (d) case study approach, and (e) net operating profit approach.

After evaluating the advantages and disadvantages of each of these methods, it was decided that the net operating profit approach held the most promise under the limitations of the study. In addition, the logical consistancy of the area of influence of market area approach is such that it is considered to have potential usefulness in future studies. Therefore, although this paper deals primarily with the net profit approach, a cursory examination of the market area approach is included in order to investigate its potential. A brief description of the merits of these two methods will serve to clarify each, and will be included in the general discussion.

NET OPERATING PROFIT APPROACH

Methodology

The net operating profit approach is based on the assumption that if time savings accruing through the use of improved highways have an assignable value, this value will be reflected through the net operating profits of the commercial highway users. A further assumption is that time savings will be utilized whenever feasible to maximize profits.

The general hypothesis of this method is that as time is saved, the commercial operators will gain an advantage in these savings through productive use of both equipment and manpower. This added productive use will create a proportionate increase in gross operating revenues as well as a similar increase in variable vehicle expenses. For conservative purposes, it is assumed that other carrier expenses such as terminal, insurance and safety, and administrative expenses will also increase in proportion to the increased revenues. However, the vehicle and labor expenses that have a time function will remain constant under the theory that hours of service will be unchanged. The productive potential will be increased only as a result of increased average operating speeds.

Another possibility is that the total volume of freight handled would not increase as time savings became available. Under these conditions, the carriers should be able to transport the same volume with fewer units of line-haul operating equipment. The potential savings under these circumstances are evident. The reduction of driver expenses, fixed vehicular expenses and the capitalization of the cost of the eliminated operating units are perhaps the most important.

However, since the total tonnage and ton miles of intercity freight moved by motor trucks have been increasing each year, it seems more logical to assume that any additional equipment time (capacity) would be utilized by increased demand for truck transport services. For this reason, the computations presented in this report are based on the assumption that the availability of additional freight is not a limiting factor.

The application of this general approach to the determination of the value of time savings required the following procedures: (a) collection of operating cost and statistical data; (b) segregation of specific line-haul expenses; (c) collection and application of mileage and frequency of occurrence data for commercial trucks (axle and gross weight groups); and (d) analysis of the impediments to the utilization of time savings. The first two of these involve technical decisions only. A complete discussion of the problems involved can be found in TTI Bulletin 23. Since frequencies and impediments are of a more unique nature, they will be discussed in detail here.

Mileage and Frequency of Occurrence of Commercial Trucks

The distribution of vehicle mileage by axle classes and carrier groups was derived from data included in the unpublished study entitled "Value Characteristics in Motor Truck Transportation." This study was conducted by the Texas Transportation Institute in cooperation with the U. S. Bureau of Public Roads. The sample of commercial vehicles included in this study consisted of 13, 663 tractor-trailer combinations as observed at various locations in the southwestern area of the United States. The number of observations, average miles per one-way trip, and percentage distribution of each axle class and each carrier group are shown in Table 1.

The distribution by relative total mileage for each group was utilized in the analysis of the mixed fleet costs. It is believed that these data are more reliable than the registration figures for each group. The registration data are sometimes difficult to segregate into either axle classes or carrier groups. For instance, in Texas the tractor and trailer are registered as separate units and there are no definite records of the registered weight, registration fee or the size of a particular combination.

Therefore, the number and type of units observed in the sample count appear to offer the best description of the units in operation within this area. The total registration fee for each combination unit was also recorded. Then the average for each axle class was computed. These average fees were used in determining the ratio of registration fees between the three major axle-class groups.

The relationships that exist between the different size units were important to this study in the allocation of composite fleet costs. The cost data that were obtained from the various carriers were applicable to the mixed line-haul fleet being operated by each particular firm. Therefore, to distribute these costs between the axle classes required an application of weighted ratios of relative costs. The development of the applicable ratios will be covered in a later section of this report.

Impediments to Utilization of Time Savings

The degree of utilization of time savings is certainly one of the major problem areas in determining the value of time saved to commercial operators. Time is definitely valuable, but the ultimate value cannot be realized unless the time is used productively. It was assumed in this study that all time would be utilized by the commercial carriers, "if the utilization of the added time would maximize profits." The determination of when to utilize the extra time is strictly a managerial decision.

The computation of the cost of operating a vehicle for an hour or per mile is basically a mechanical process. There are some differences of opinion as to the specific expenses that would remain constant under conditions of time savings. However, these differences and the resultant value of an hour's saving of time are rather minor when compared to the difference of opinion regarding the percent of time savings that can be profitably utilized. There is no general consensus among vehicle operators or researchers in the field of transportation with respect to the probable effect of the various impediments or barriers to the utilization of time. One barrier may be very significant to a general freight carrier but be of no consequence to a contract carrier and vice versa.

If each impediment could be assigned a weighting factor for each carrier, then a rather comprehensive and accurate utilization factor could be computed for each firm and for each carrier group. However, until detailed case studies of the utilization of time problem are conducted, the results of this study must rely on value judgment. Under these conditions, it should be emphasized that any projection of values derived by this study should be considered as estimates and are, therefore, expressed in terms of a range of probable upper and lower limits.

The utilization of time savings is a gradual process. This makes it difficult to segregate the savings because they tend to become obscured within the routine of business operations. Therefore, to determine the degree of utilization of time savings, it becomes necessary to view the problem from both a short-term and a long-term position.

In the short run, there are numerous barriers to the utilization of time savings. A majority of the intercity drivers are paid on a mileage basis, thereby eliminating any immediate savings through wage adjustments as a result of decreased trip time. Existing ICC and state regulatory agency route and area restrictions are rather rigid and tend to stifle a firm's expansion into new geographic areas. Route restrictions also sometimes hinder a carrier from taking advantage of new highway facilities. Therefore, if the objective is to determine the value of time savings to a particular group of firms, then it must be remembered that the utilization percentages for such firms are lowered due to these restrictions. However, if the value of time savings resulting from operations on a particular facility is the point of consideration, the consequent reduction in

TABLE 1

DISTRIBUTION OF VEHICLE MILEAGE BY AXLE CLASS AND CARRIER GROUPS[a]

Group	No. Observations	Avg. One-Way Trip Miles	Total Miles	Percentage Distribution	Total Miles by Axle Class	Total Miles by Carrier Groups
Axle class:						
2-S1	3,044	504	1,532,834	25.9		
2-S2	9,045	406	3,668,311	61.9		
3-S2	1,574	457	719,845	12.2		
Total	13,663	434	5,920,990	100.0		
Common carrier:						
2-S1	212	731	154,972	17.2	10.1	
2-S2	1,389	311	431,979	47.8	11.8	
3-S2	985	321	316,185	35.0	43.9	
Subtotal	2,584	349	903,136	100.0		15.3
Special hauler:						
2-S1	704	745	524,480	32.9	34.2	
2-S2	2,176	419	911,744	57.2	24.9	
3-S2	184	855	157,320	9.9	21.9	
Subtotal	3,064	520	1,593,544	100.0		26.9
Contract hauler:						
2-S1	87	472	41,064	45.5	2.7	
2-S2	122	301	36,722	40.6	1.0	
3-S2	55	342	12,540	13.9	1.7	
Subtotal	264	342	90,326	100.0		1.5
Private:						
2-S1	2,041	398	812,318	24.4	53.0	
2-S2	5,358	427	2,287,866	68.6	62.3	
3-S2	350	668	233,800	7.0	32.5	
Subtotal	7,749	430	3,333,984	100.0		56.3
Total			5,920,990			100.0

[a]Slater, J. Nelson, and Ray, Cadwell L. Determination of Value Characteristics in Motor Truck Transport. Unpublished report to U. S. Bureau of Public Roads, April 1961.

utilization percentages would not be the pertinent factor. It should be pointed out, however, that even when the value of time saved on a particular facility is the prime consideration, the value will sometimes be affected by a firm's inability to operate on other improved highways, particularly if such operation would facilitate the use of time saved on that particular facility. The utilization hindrances of this nature would be of little consequence in the short run and of no consequence in the long run.

The present location of terminal facilities and the existing trip schedules will both require adjustments in many instances before the time can be fully utilized. Therefore, it appears logical that a study such as this should be directed along two avenues. First, there would be the potential value that might accrue to the commercial users, assuming no external interference and a minimum amount of internal problems. This long-run approach assumes that all of the factors that act as present barriers to the utilization of time savings will have had sufficient time to adjust and be altered to the extent that they no longer operate as impediments to the firms.

The short-run approach will attempt to weigh the effect of the existing impediments and adjust the potential value of time savings accordingly.

Each class of carriers has different problems to cope with in the utilization of time saved. Practically all of the major common carriers of general freight base their driver wages on a combination of hourly and mileage rates. The hourly rate serves as a guaranteed minimum. However, the mileage pay scale is more prevalent since most trips can be completed within time limits that make the mileage rate basis more advantageous to the driver.

The specialized and contract carriers pay their drivers on either an hourly, mileage, fixed trip fee, or a percentage of revenue basis. The method of computing the pay varies greatly between individual carriers in this major group as well as between the major types of specialized and contract carriers.

There is a belief that wage considerations are fundamentally based on total take-home pay and the mileage basis or percent of revenue basis is only a means of attaining that end. If this premise is acceptable, then it appears logical that as trip travel time decreases, the fixed rate charges will be adjusted accordingly. This adjustment of per mile rates, etc., does not necessarily mean a downward revision of existing rates. This is highly improbable under current labor conditions. However, it is possible that the future rate increases might be smaller than they would have been if there had been no changes in trip time requirements. There is a psychological element involved that could be very important at the bargaining table.

With the savings of time accruing to the commercial highway users, it is feasible that the individual carriers could add a new service area to existing "runs." However, unless the firm has existing authority to serve that area, the carrier must obtain a certificate of necessity before it can add this area to its service route. Increasing competition within the motor transport industry is making it more difficult to obtain such certificates. Therefore, unless a firm can reschedule the trips within the existing framework of operating authority, there is a good possibility that much of the potential time savings will not be fully utilized.

The amount of time that can be saved per trip also plays an important role in determining the degree of possible utilization. For instance, a savings of 45 to 60 minutes on a one-way trip of 200 miles is not of great significance under normal conditions (although the dispatcher would undoubtedly welcome this leeway in his scheduling). A similar ratio of time savings to miles driven for a cross-country operation will frequently yield a more than proportionate savings in time as well as dollar savings. On long-distance trips, the time savings are cumulative and are often increased by elimination of layover periods. The ICC safety regulations stipulate that no driver may drive more than 10 hours at a time in any period of 24 consecutive hours unless such driver be off duty for 8 consecutive hours during or immediately following the 10 hours driving. This means that on trips that require more than 10 hours of driving time, layovers are required. Each layover period that is thus eliminated will add a minimum of 8 hours to the total saved. This amount of time is significant from the customer service standpoint and in the area of equipment utilization.

After considering the problems involved in the utilization of incremental time savings, certain conclusions and estimates have been made. All time saved as a result of highway improvements is valuable to the carriers whether it is used for additional preventative maintenance or for providing more freedom in the scheduling of trips.

To adjust the potential savings to reflect more closely current or short-term values, it became necessary to establish certain time utilization estimates for each carrier group. During the interviews with the respondent carriers, several questions regarding the time utilization problem were discussed. The answers, of course, were expressions of the respondents' informed judgments concerning the problem. The answers, as interpreted by the researchers, were converted to measurement and scaling techniques by use of scaling methods. The value of the scaling technique lies in its transformation of qualitative and noncomparable quantitative information into numerical rankings. Such rankings, moreover, permit the subsequent use of various quantitative techniques.

Based on the results of the scaling measurement and subjective judgment, the following ranges of probable utilization were established.

The common carriers of general freight, being the most heavily restricted as to the routes traveled and areas served, and operating predominantly with organized labor, received the lowest estimates, a range of 40 to 60 percent of potential value.

Within the specialized carrier group there are both regular and irregular route carriers, long- and short-haul carriers and carriers that have based their driver wages on a mileage, percent of revenue or hourly rate. Normally, these carriers have a greater degree of freedom in their operations than the general freight carriers. Accordingly, the specialized carrier group was estimated to be able to use approximately 60 to 80 percent of any time saved.

The private and contract haulers are less regulated and restricted in their operations than either of the preceding carrier groups. They have much more freedom in their scheduling, routing, and service areas. The major impediments to the complete utilization of time savings center around internal rather than external restrictions and problems. The private and contract carriers were assigned a utilization range of 80 to 100 percent.

Development of Value of Time Savings by Carrier Groups

The estimates of value for each group of commercial carriers are founded on several assumptions. It is assumed that, as additional time (equipment capacity) becomes available, the added capacity will be utilized through additional freight volume. This incremental volume will produce a proportionate increase in gross operating revenues as well as a similar increase in variable and semi-variable expenses. Therefore, the value accruing through this added capacity is the difference between the incremental gross revenues and the incremental expenses. The savings are thus an amount equal to the selected expenses (as described previously) which are not incurred in the incremental shipment plus the average net profit per unit of measure. The unit of measure employed in the tables and computations in this section is the "intercity mile." The revenue, expenses and potential value added are all expressed in terms oi "per intercity miles." The potential value added per mile is expanded to the value per hour by multiplying by the average line-haul speed, expressed in miles per hour.

The average line-haul operating speed of 38 mph was used for all of the commercial freight carriers. This average speed was determined by sampling trip records and driver log sheets and was confirmed through conferences with dispatchers and other carrier officials.

The major variations in operating speeds appeared to be between specific routes and between different types of specialized and contract carriers. For instance, the heavy equipment haulers' average operating speed is not as high as the grain haulers'. However, the average for each group of carriers appears to be comparable for the general freight, specialized, contract and private carriers.

The revenues and variable expenses, that is, total expenses less the selected expenses, of each class of carriers were weighted according to the relative mileage of each class to the total mileage of the group. This weighting has the effect, of course, of giving prime importance to the revenues and expenses of the carrier class that has the greatest utilization of the highways in the southwestern region. The weighting factors were developed from sample Loadometer data and average miles per firm information for each study carrier.

The carriers are subgrouped in the various tables and computations into Class I, Class II, and Class III carriers (Table 2). These classifications conform to the Interstate Commerce Commission's designations. However, the Class III subgroup also includes intrastate carriers that are not included under the jurisdiction of the ICC. The terms intrastate and Class III carriers may, at times, be interchanged in this paper since they are both used to refer to the group of smaller carriers included in the study. These smaller carriers may be either intrastate or interstate in character.

TABLE 2

NUMBER OF CARRIERS INCLUDED IN STUDY

Carrier Group	Class I	Class II	Class III
Common carriers of general freight	35	25	19
Common carriers of passengers	23	--	7
Common carriers of commodities other than general freight	32	69	88
Contract carriers	3	7	29

TABLE 3

SUMMARY OF REVENUE AND SELECTED LINE-HAUL EXPENSES FOR CARRIERS OF GENERAL FREIGHT[a]

Factor	$ per Mile						
	Class I			Class II			Class III
	A[b]	B[c]	Total	A[b]	B[c]	Total	
Operating revenue	0.73244	0.78317	0.75289	0.91857	0.96028	0.92888	0.30788
Total expenses	0.68808	0.71985	0.70088	0.88652	0.96424	0.90573	0.30285
Selected line-haul expenses:							
Drivers' wages	0.10127	0.10449	0.10257	0.10683	0.08906	0.10244	0.03615
Employees' welfare	0.00273	0.00259	0.00267	--	--	--	--
Workmen's compensation	0.00161	0.00171	0.00165	0.00299	0.00251	0.00287	0.00078
Vehicle license and registration fees	0.00999	0.00980	0.00991	0.01279	0.01798	0.01407	0.00596
Real estate and personal property taxes	0.00223	0.00173	0.00206	0.00166	0.00050	0.00139	0.00084
Social security taxes	0.00177	0.00197	0.00185	0.00276	0.00260	0.00272	0.00097
Total	0.11960	0.12229	0.12071	0.12703	0.11265	0.12349	0.04470

[a]Engages in intercity operations, southwestern region and Texas, for year ending Dec. 31, 1959.
[b]Operating principally with owned equipment.
[c]Operating with owned and leased or purchased transportation.

Common Carriers of General Freight.—A summary of the revenues and selected expenses per mile is presented in Table 3. It is quite apparent that the major expense involved in determining the potential value of time saved is that of driver wages. It should be remembered that, under current conditions, this expense is primarily variable for this group of carriers.

The derivation of the potential value added per mile (as a result of time savings) for the common carriers of general freight is shown in Table 4. The Class I carriers had the greatest influence on this group since they accounted for approximately 88 percent of the total mileage.

When the value added per mile is converted to an hourly basis, the potential value of $6.17 per hr is obtained. Application of the probable utilization percentages yields a range of probable values of $2.47 to $3.70 per hr of time saved (see Table 10 for summary).

TABLE 4

DERIVATION OF POTENTIAL VALUE ADDED PER INTERCITY MILE FOR COMMON CARRIERS OF GENERAL FREIGHT

Class	Class Mileage / Total Mileage	Revenue per Mile ($)	Weighted Revenue per Mile ($)	Expenses per Mile ($)[a]	Weighted Variable Expenses per Mile ($)
I	0.88328	0.75289	0.66501	0.58017	0.51245
II	0.04123	0.92888	0.03830	0.78224	0.03225
III	0.07548	0.30788	0.02324	0.25815	0.01949
Total			0.72655		0.56419
Potential value added					0.16236[b]

[a]Total expenses less selected expenses.
[b]Difference of weighted revenue and weighted variable expenses.

TABLE 5

SUMMARY OF REVENUE AND SELECTED LINE-HAUL EXPENSES FOR CARRIERS OF COMMODITIES OTHER THAN GENERAL FREIGHT[a]

Factors	$ per Mile		
	Interstate		Class III[b]
	Class I	Class II	
Operating revenue	0.34942	0.42558	0.56734
Total expenses	0.33199	0.40739	0.52125
Selected line-haul expenses:			
Drivers' wages	0.05715	0.08027	0.10939
Employees' welfare	0.00142	--	--
Workmen's compensation	0.00246	0.00583	0.00737
Vehicle license and registration fees	0.00833	0.01012	0.01261
Real estate and personal property taxes	0.00069	0.00057	0.00205
Social security taxes	0.00051	0.00094	0.00199
Total	0.07056	0.09773	0.13341

[a]For carriers of commodities other than general freight, southwestern region, for year ending Dec. 31, 1959.
[b]All intrastate information for year ending Dec. 31, 1960.

Common Carriers of Commodities Other Than General Freight. —The group of common carriers of commodities other than general freight are generally considered specialized carriers. They include the haulers of petroleum products, household goods, heavy machinery, automobiles, exempt agricultural products, and various other specific commodities. It is within this group of carriers that the greatest variation in both physical operations and the cost of operation occurs.

Table 5 presents the pertinent revenue and expenses data for the three classes of specialized carriers. The derivation of the potential value added per mile is shown in Table 6. Classes I and III accounted for almost 86 percent of the total estimated mileage by the specialized group of carriers. This is apparent in the calculations of the weighted revenues per mile and the weighted variable expenses per mile as presented in Table 6.

The potential value added for the common carriers of commodities other than general freight is estimated to be slightly less than $0.13 per mile. This is approximately 20 percent lower than the estimate for the common carriers of general freight. However, the probable value added is greater than for the general freight haulers because the level of probable utilization is higher.

The potential value per hour of time saved for this group is estimated $4.86. The low value of the probable range is $2.91 and the high value is $3.89. This range is based on the estimated utilization of 60 to 80 percent.

Contract and Private Carriers. —The contract and private carriers' costs are assumed to be comparable for purposes of this study. Therefore, this subsection includes the derivation of estimated values of time savings for both groups.

The selected expenses and revenues for the three classes of contract carriers are listed in Table 7. The derivation of the potential value added per mile in Table 8 applies to both carrier groups and is weighted accordingly.

The smallest class of carriers in this group accounted for the highest percentage of total mileage. Therefore, their revenues and expenses were weighted the heaviest.

TABLE 6

DERIVATION OF POTENTIAL VALUE ADDED PER INTERCITY MILE FOR COMMON CARRIERS OF COMMODITIES OTHER THAN GENERAL FREIGHT

Class	Class Mileage / Total Mileage	Revenue per Mile ($)	Weighted Revenue per Mile ($)	Expenses per Mile ($)[a]	Weighted Variable Expenses per Mile ($)
I	0.46555	0.34942	0.16267	0.26143	0.12171
II	0.14253	0.42558	0.06066	0.30966	0.04414
III	0.39192	0.56734	0.22235	0.38784	0.15200
Total			0.44568		0.31785
Potential value added					0.12783[b]

[a]Total expenses less selected expenses.
[b]Difference of weighted revenue and weighted variable expenses.

TABLE 7

SUMMARY OF REVENUE AND SELECTED LINE-HAUL EXPENSES FOR CONTRACT CARRIERS[a]

Factors	$ per Mile		
	Interstate		Class III[b]
	Class I	Class II	
Operating revenue	0.32077	0.38622	0.33513
Total expenses	0.27863	0.36880	0.32294
Selected line-haul expenses:			
Drivers' wages	0.09316	0.07837	0.07057
Employees' welfare	0.00131	--	--
Workmen's compensation	0.00063	0.00210	0.00284
Vehicle license and registration fees	0.00776	0.01186	0.00934
Real estate and personal property taxes	0.00101	0.00047	0.00162
Social security taxes	0.00074	0.00066	0.00149
Total	0.10461	0.09346	0.08586

[a]Southwestern region, for year ending Dec. 31, 1959.
[b]All intrastate information for year ending Dec. 31, 1960.

The potential value added per mile for the contract and private carriers was estimated to be approximately $0.11 per mile. Converted to an hourly figure through use of the 38 mph average speed, the potential time savings are estimated to be valued at $4.32 per hour. Application of the utilization range of 80 to 100 percent yields a low value of $3.46 per hour and a high value of $4.32 per hour.

The estimated probable values accruing to these carriers are the highest of any of the commercial freight haulers. The validity of these figures is dependent on the accu-

TABLE 8

DERIVATION OF POTENTIAL VALUE ADDED PER INTERCITY FOR CONTRACT AND PRIVATE CARRIERS

Class	Class Mileage / Total Mileage	Revenue per Mile ($)	Weighted Revenue per Mile ($)	Expenses per Mile ($)[a]	Weighted Variable Expenses per Mile ($)
I	0.28060	0.32077	0.09001	0.17402	0.04883
II	0.15705	0.38622	0.06066	0.27534	0.04324
III	0.56235	0.33513	0.18846	0.23708	0.13332
Total			0.33913		0.22539
Potential value added					0.11374[b]

[a]Total expenses less selected expenses.
[b]Difference of weighted revenue and weighted variable expenses.

racy of the judgment values employed in determining the probable extent of time utilization by each class carrier.

Composite Commercial Freight Vehicle. —This subsection deals with the derivation of the values of time for a composite commercial freight vehicle. The composite vehicle is defined as an average vehicle, composed of the four freight carrier groups, operating in the southwestern region.

The value added per hour for a composite vehicle is derived through employment of the values developed in Tables 4, 6, and 8, together with the ratios in Table 1, in the following formula:

$$p_1(G) + p_2(S) + p_3(N) + p_4(P) = p_t(C_t) \tag{1}$$

where

p_1, p_2, p_3, p_4 = ratio of each of four carrier groups' miles operated to total miles operated by all carrier groups (respectively, common carriers of general freight, common carriers of commodities other than general freight, contract carriers, and private carriers);

p_t = ratio of miles operated by carrier groups used in a particular equation to total miles operated by carrier groups making up particular costs or revenues solved for (by this definition this ratio equal to one and added here simply for mathematical clarity);

G, S, N, P = value added per hour for, respectively, common carriers of general freight, common carriers of commodities other than general freight, contract carriers, and private carriers as computed in Tables 4, 6, and 8; and

C_t = value added per hour for a composite vehicle composed of four carrier groups.

By using the values in Tables 1, 4, 6 and 8, three values may be developed for a composite vehicle:

1. Potential value (100% for all carriers)
$$0.153(\$6.16968) + 0.269(\$4.85754) + 0.015(\$4.32212) + 0.563(\$4.32212) = C_t$$
$$C_t = \$4.74803 \text{ per hour}$$
2. Low value
$$0.153(\$2.46787) + 0.269(\$2.91452) + 0.015(\$3.45770) + 0.563(\$3.45770) = C_t$$
$$C_t = \$3.16054 \text{ per hour}$$

3. High value

$$0.153(\$3.70181) + 0.269(\$3.88603) + 0.015(\$4.32212) + 0.563(\$4.32212) = C_t$$
$$C_t = \$4.11014 \text{ per hour}$$

Therefore, assuming a commercial freight traffic stream consisting of approximately 15 percent general freight carriers, 27 percent specialized carriers, and 58 percent private and contract carriers, the potential value of an hour of time saved would average \$4.74 for all vehicles. The average low-high utilization values would be approximately \$3.16 to \$4.11 per hour of time saved.

It is readily apparent from the formula that the composite vehicle values are heavily weighted by the private carriers. Any shift in the composite traffic stream would automatically cause a change in the computed values for the composite vehicle.

It should be noted that the value range of \$3.16 per hour to \$4.11 is derived under assumptions that are based on the short-run period. However, this does not imply that these conditions and assumptions are currently operative. Therefore, the current values are probably somewhat lower than the value of \$3.16 per hour. This will be true until adjustments are consummated in regard to driver wage payments since the possible savings that may accrue through this expense are responsible for the major portion of the estimated value of time savings.

Development of Value of Time Savings by Axle Classes within Carrier Groups

The purpose of this section is to develop the potential and probable values of time savings for each of the three major axle classes of commercial freight vehicles. The estimates are developed for each axle class within each major carrier group. Estimates of values are also derived for a composite vehicle of each axle class. The composite vehicles are composed of each carrier group weighted by the proportionate mileage factors as developed for the southwestern region.

The value added per mile for the various axle classes within each carrier group is developed using the following formula:

$$(R - E) + S = V \tag{2}$$

where

- R = total revenue per intercity mile for particular carrier group;
- E = total expenses per intercity mile for particular carrier group;
- S = selected expenses per intercity mile for particular axle class within carrier group; and
- V = value added per mile for each axle class.

The values for (R - E) in Eq. 10 are taken from Column 1 of Tables 4, 6, and 8 and the values for S are taken from Table 10, which is a summary of the cost of selected line-haul expenses by axle class and carrier group.

Common Carriers of General Freight

1. Axle class 2-S1
   $\$0.04728 + \$0.1107 = V$
   $V = \$0.15798$ per mile
2. Axle class 2-S2
   $\$0.04728 + \$0.1157 = V$
   $V = \$0.16298$ per mile
3. Axle class 3-S2
   $\$0.04728 + \$0.1162 = V$
   $V = \$0.16348$ per mile

Common Carriers of Commodities Other Than General Freight

1. Axle class 2-S1
   $\$0.02877 = \$0.0960 = V$
   $V = \$0.12477$ per mile

TABLE 9

SUMMARY OF VALUE ADDED DERIVATIONS

Group	Value Added ($ per mi)	Average Speed (mph)	Potential Value Added ($ per hr)	Percent Range of Utilization	Range of Value ($)	
					Low	High
Common carriers of general freight	0.16236	38	6.16968	40-60	2.46787	3.70181
Common carriers of commodities other than general freight	0.12783	38	4.85754	60-80	2.91452	3.88603
Contract and private carriers	0.11374	38	4.32212	80-100	3.45770	4.32212
Composite vehicle	0.12485	38	4.74803	--	3.16054	4.11014

TABLE 10

COST OF SELECTED LINE-HAUL EXPENSES[a]

Group	Cost ($ per mi)			
	Axle Class			Group Avg.
	2-S1	2-S2	3-S2	
Common carriers of general freight	0.10954	0.11528	0.11751	0.1151
Common carriers of commodities other than general freight	0.09554	0.10051	0.10236	0.0991
Contract carriers	0.089420	0.09438	0.09573	0.0923
Private carriers	0.08881	0.09329	0.09496	0.0923
Composite vehicle	0.09323	0.09772	0.10653	0.09760

[a]From technical development of axle-class ratios by TTI.

2. Axle class 2-S2
   $0.02877 + $0.1004 = V
   V = $0.12917 per mile
3. Axle class 3-S2
   $0.02877 + $0.1008 = V
   V = $0.12957 per mile

Contract Carriers

1. Axle class 2-S1
   $0.02143 + $0.0900 = V
   V = $0.11143 per mile
2. Axle class 2-S2
   $0.02143 + $0.0941 = V
   V = $0.11553 per mile
3. Axle class 3-S2
   $0.02143 + $0.0945 = V
   V = $0.11593 per mile

Private Carriers

1. Axle class 2-S1
   $0.02143 + $0.0892 = V
   V = $0.11063 per mile

2. Axle class 2-S2
   $\$0.02143 + \$0.0932 = V$
   $V = \$0.11463$ per mile
3. Axle class 3-S2
   $\$0.02143 + \$0.0936 = V$
   $V = \$0.11503$ per mile

A summary of the potential and probable range of values is shown in Table 11. These hourly values are derived from the preceding mileage values. The average line-haul operating speed of 38 mph was used to determine the potential value per hour and the low-high ranges of probable values were computed, using the previously established estimates of time utilization factors for each carrier group.

The values, as developed in this section, are based on the assumption that each axle-class vehicle within a particular carrier group has an equal net operating profit potential. It is believed that the resultant error occurring as a result of the acceptance of this assumption will not be of major consequence, even though there is undoubtedly some variation. The major variation in net operating profit potential results from differences between carrier groups rather than axle classes. Since it is impossible to determine from available data the variation between both carrier groups and axle classes, the groups were segregated by carrier groups, the major source of variation.

Composite Axle Classes.—The value added per hour for composite axle-class groups may be developed from the information in Table 11, together with the values from Table 1, by the following equation:

$$p_1(G) + p_2(S) + p_3(N) + p_4(P) = p_t(C_a) \tag{3}$$

where

p_1, p_2, p_3, p_4 = ratio of the number of miles operated by a particular axle class within a carrier group to the total miles operated by that axle class within the four carrier groups (respectively, common carriers of general freight, common carriers of commodities other than general freight, contract carriers, and private carriers);

p_t = ratio of miles operated by a particular axle class in all carrier groups, used in a particular equation, to total miles operated by that axle class within carrier groups making up costs or revenues solved for (equal to one in all following equations);

G, S, N, P = value added per hour for a particular axle class within each carrier group (respectively, common carriers of general freight, common carriers of commodities other than general freight, contract carriers, and private carriers); and

C_a = value added per hour for a composite axle-class vehicle composed of that axle class within each carrier group.

By using the values in Tables 1 and 11, three values may be developed for each composite axle class:

Composite 2-S1 axle class

1. Potential value
   $0.101(\$6.00324) + 0.342(\$4.74126) + 0.027(\$4.23434) + 0.530(\$4.20394) =$
   $\$4.57051$ per hour
2. Low value
   $0.101(\$2.40130) + 0.342(\$2.84476) + 0.027(\$3.38747) + 0.523(\$3.36315) =$
   $\$3.08919$ per hour
3. High value
   $0.101(\$3.60194) + 0.342(\$3.79301) + 0.027(\$4.23434) + 0.530(\$4.20394) =$
   $\$4.00329$ per hour

Composite 2-S2 axle class

1. Potential value

0.118($6.19324) + 0.249($4.90846) + 0.010($4.39014) + 0.624($4.35594) = $4.70997 per hour

2. Low value

   0.118($2.47730) + 0.249($2.94508) + 0.010($3.51211) + 0.624($3.48475) = $3.23225 per hour

3. High value

   0.118($3.71594) + 0.249($3.92677) + 0.010($4.39014) + 0.623($4.35594) = $4.17424 per hour

Composite 3-S2 axle class

1. Potential value

   0.439($6.21224) + 0.219($4.92366) + 0.017($4.40534) + 0.325($4.37114) = $5.30117 per hour

2. Low value

   0.439($2.48490) + 0.219($2.95420) + 0.017($3.52427) + 0.325($3.49691) = $2.93426 per hour

3. High value

   0.439($3.72734) + 0.21855($3.93893) + 0.017($4.40534) + 0.325($4.37114) = $3.99449 per hour

A summary of the value added per hour for each composite axle-class commercial vehicle is shown in Table 12. It is interesting to note that the potential value added per hour increases with the number of axles but the probable range of values added per hour does not follow this pattern. The range of probable values for the 3-S2 axle class is less than for either of the other axle classes although the potential value is the greatest for the 3-S2 axle class. A combination of factors enters into the explanation of this apparent incongruity.

TABLE 11

SUMMARY OF VALUE ADDED DERIVATIONS

Group	Value Added ($ per hr)		
	Potential	Low Utilization	High Utilization
Common carriers of general freight:			
2-S1	6.00	2.40	3.60
2-S2	6.19	2.48	3.72
3-S2	6.21	2.48	3.73
Common carriers of commodities other than general freight:			
2-S1	4.74	2.84	3.79
2-S2	4.91	2.95	3.93
3-S2	4.92	2.95	3.94
Contract carriers:			
2-S1	4.23	3.39	4.23
2-S2	4.39	3.51	4.39
3-S2	4.41	3.52	4.41
Private carriers:			
2-S1	4.20	3.36	4.20
2-S2	4.36	3.48	4.36
3-S2	4.37	3.50	4.37

TABLE 12

SUMMARY OF VALUE ADDED DERIVATIONS

Composite Vehicle	Value Added ($ per hr)		
	Potential	Low Utilization	High Utilization
2-S1	4.57	3.09	4.00
2-S2	4.71	3.23	4.17
3-S2	5.30	2.93	3.99

The greatest use of the 3-S2 vehicles in the southwestern region study was by the common carriers of general freight, accounting for approximately 44 percent of the total mileage. This carrier group had the highest potential value of time savings but the lowest range of probable values. The private carriers accounted for the predominant usage of the 2-S1 and 2-S2 vehicles. These private carriers had the lowest potential values but the highest range of probable utilization. Therefore, the 2-S1 and 2-S2 axle classes are weighted more heavily by the higher utilization carrier groups, whereas the 3-S2 axle class is weighted more heavily by the lower utilization carrier groups.

This situation serves to illustrate the importance of the relative composure of the composite axle-class vehicles and the importance of the estimated range of probable utilization in the dollar value estimates of time savings.

AREA OF INFLUENCE OR MARKET AREA APPROACH

Methodology

The market area technique borrows from the field of location theory. The basic concept of this theory is that business locations can be determined rather scientifically by measuring each major locational factor and weighting each according to its relative importance to each specific business. Different businesses vary markedly in the extent to which they are transportation oriented. Therefore, costs of transportation and time requirements become decisive factors in the plant site selection.

Using certain facets of the plant location theory, it is possible to adapt the market area technique to the problem of determining the value of time savings. This concept may be utilized as an alternative process. Since it relies heavily on hypothetical assumptions, the measure of check that it provides is perhaps its most important potential. Since private trucking cost figures are rather difficult to obtain, the market area approach was tested using a large general merchandising firm that operates a private fleet of trucks in its distribution process.

Some of the basic hypotheses tested are as follows:

1. If a firm is operating with privately owned equipment, then time savings will enable the firm to expand its operations by an amount equal to the time savings.

2. If the transportation in question is used in supplying raw materials to the manufacturing sector, then the potential amount of raw materials carried will increase by an amount proportionate to the time savings. (The capacity of the manufacturing sector may be a limiting factor, however.) If the transportation in question is used in the supplying of marketing centers, then the firm may either increase the supply to existing centers by an amount proportionate to the time savings, or extend the radius of their distribution area thereby increasing their area of market influence.

3. Under certain circumstances, particularly when transportation costs represent a significant proportion of total costs, time savings may result in decreased costs which would enable the firm to benefit from existing operations or to expand into new areas that were previously unprofitable.

This general approach appears to be of most value in analyzing an individual firm's operations as opposed to an industry-wide study. For a single firm, this method would tend to provide insight into the value of time saved in relation to inventory costs, driver layover expenses, warehouse costs, flexibility of operations and customer service.

It appears to be of limited value when considering the regulated for-hire carrier operations. This is due mainly to the inflexibility created by regulatory restrictions. These restrictions affect both routes traveled and areas served in many cases. Under these conditions, the short-run opportunities for expanding the service area are rather limited for these carriers.

Generally speaking, each industry has three basic needs: (a) to accumulate its required raw materials and services at a manufacturing center; (b) to convert these resources into finished products at the manufacturing center; and (c) to distribute the finished products from the manufacturing center to the various market outlets. Transportation is required in the first and third of these processes.

In certain cases the distribution process may be carried out in separate stages. In these instances the products are first moved from the manufacturer to wholesalers, jobbers or other distribution centers from which they are then shipped to the retail outlets. Consumers then usually assume the burden of transporting the goods from the retail store to their final place of consumption.

The particular operation under consideration in this paper is a merchandising firm with a regional distribution center, located in Dallas, from which its products are distributed to retail outlets. This final movement may be either by way of common carriers of general freight or by the firm's private fleet of trucks.

The following discussion is divided into three parts, each showing a way in which time savings might be of value to such a firm. The first part shows how time savings might be of value to a firm if such savings allowed the firm to supply more of their retail outlets with their private fleet, rather than having to use for-hire carriers. The second part shows how the firm might use time savings to supply increased business to existing retail outlets. The third part shows how time savings might, in certain restricted cases, allow a firm to locate new retail outlets in previously unprofitable locations.

General Value of Time Savings Under Present Operations

Under present operations, time savings would be of value to the private fleet by allowing them (a) to increase the use of their own trucks (instead of for-hire carriers) in hauling products to their retail outlets, and (b) to operate this mileage at reduced costs. It is assumed that the number of miles operated by both for-hire carriers and by the private fleet, in serving the retail outlets, remains constant. That is, the amount of products carried to the retail outlets is assumed to remain constant, and the number of miles operated in carrying these products is likewise assumed to remain constant. The total transportation costs per year paid by the merchandising firm to serve its retail outlets are given by:

$$E_t = r(B) + c(D) \tag{4}$$

where

E_t = total transportation expenses per year;
r = common carrier rates per mile (although common carrier rates are not given in mileage figures, it is possible to develop such an average figure for known operations over a period of time);
c = private carrier costs per mile of operation;
B = miles operated by common carriers of general freight for the merchandising firm; and
D = miles operated by private fleet of the merchandising firm.

When the merchandising firm's potential miles operated by its private fleet increases (ΔD) due to time savings (due to increased speeds on the Interstate System) utilized, the miles operated for the firm by common carriers of general freight will decrease by an equal amount ($\Delta B \equiv -\Delta D$, recalling the assumption that total miles operated per year remain constant). Furthermore, these changes in mileage will be accompanied by a change in total transportation expenses (ΔE_t), since r and c, or r and (c - s) below, are not equal:

$$E_t + \Delta E_t = r(B - \Delta D) + c(D + \Delta D) \quad (5)$$

Subtracting Eq. 4 from Eq. 5 gives Eq. 6 which shows the change in total expenses which results from the increase in miles operated by the private fleet and the decrease in miles operated by common carriers for the firm:

$$\Delta E_t = r(-\Delta D) + c(\Delta D) \quad (6)$$

However, since the additional mileage operated by the private fleet is accomplished with the same number of operating hours, the expenses for the private fleet on the additional mileage are not equal to c; rather, they are equal to the private carrier costs per mile before time savings occurred (c) less selected expenses per mile (designated hereafter as s) not occurring on the additional mileage. The reasoning used here is identical to that used in the discussion of commercial haulers. Using (c - s) to represent the expenses per mile on the additional private carrier miles operated, Eq. 7, showing the change in total transportation expenses from both the changeover from common carrier to the private fleet and the reduced expenses on the additional mileage, is obtained:

$$\Delta E_t = r(-\Delta D) + (c - s)(\Delta D) \quad (7)$$

There exist various impediments to changing from common carrier to the private fleet (such as rescheduling, route and load limitations) and other institutional factors prohibiting maximum savings of selected expenses on additional mileage (such as drivers paid on mileage basis and equipment utilization). Therefore, the total expense change will be less than ΔE_t. The actual change in total expenses ($\Delta E_t'$) will be represented as 50 percent of the potential change (ΔE_t), a percentage lower than that for private carriers in general[1] due to the particular institutional factors present in this firm's operation:

$$\Delta E_t' = \frac{\Delta E_t}{2} = \frac{r(-\Delta D)}{2} + \frac{(c - s)(\Delta D)}{2} \quad (8)$$

The change in the total miles operated by the private fleet (ΔD) may be derived from the following formula:

$$\Delta D = p(D)/S_o (S_i - S_o) \quad (9)$$

where

- D = total miles operated per year by the private fleet;
- p = ratio of miles operated in 1961 on roads which will be part of the Interstate Highway System to the total miles operated on all roads during 1961;
- S_o = the average speed of the private fleet during 1961;
- S_i = the estimated speed of the private trucks while operating on the Interstate System; and
- ΔD = the potential increase in total miles operated by the private fleet due to increased speed on the Interstate System, assuming the same number of driving hours by the private fleet.

Substituting the value for ΔD from Eq. 9 into Eq. 8 gives:

$$\Delta E_t' = \frac{r[(-pD/S_o)(S_i - S_o)]}{2} + \frac{(c - s)[(pD/S_o)(S_i - S_o)]}{2} \quad (10)$$

[1] See the discussion of private carriers in Net Operating Revenue Approach.

The total savings per year ($\Delta E_t'$) may be transformed into value per hour of time saved on Interstate highways (H_s) by Eq. 11 or into savings per potential mile saved on Interstate highways (M_s) by Eq. 12:

$$H_s = \Delta E_t'/(\Delta D/S_i) \tag{11}$$

$$M_s = H_s/S_i \tag{12}$$

The change in total transportation expenses per year due to increased speeds of operation ($\Delta E_t'$) may be obtained by using Eq. 10 together with the following information: r = \$0.46995; p = 0.6532; D = 4,517,824 miles; S_o = 38.011 mph; c = \$0.33144; and s = \$0.14187.

The common carrier rates per mile(r), obtained from the private firm under consideration, which has been developed from past years' operations. The firm has kept records showing the cost of using common carriers instead of the private fleet; the common carrier rates have averaged 1.4179 times as much per mile as the cost of hauling the same goods with the private fleet (1.4179 times \$0.33144 equals \$0.46995). All the other statistics are taken from the records of the firm under consideration for the year ended 1961. The p and S_o are taken from a sample of all trips dispatched during 1961. All other statistics cover the entire year's operation. The derivation of cost of selected expenses per mile is shown in Table 13.

Since the operating speed on the Interstate System may not yet be determined accurately, the values of time saved are computed for increased speeds varying from 39 to 45 mph. For each of these speeds, Table 14 gives a total yearly change in transportation expenses, value per hour or time saved on Interstate highways, and savings per potential mile saved on Interstate highways. After the average operating speed on the Interstate System has been ascertained, the value of time savings per year, hour, and mile may be approximated by simply referring to the speed in the table. (If the speed differs from the values shown in the table, then other values may be readily computed by use of their given formulas.) For example, the value of one hour of time saved on Interstate highways at an average speed of 42 mph is worth approximately \$5.89.

Extension of Market Area

The merchandising firm under consideration has a central distribution center located in Dallas from which it serves its many retail outlets located in Texas, Louisiana, Oklahoma, and New Mexico. In the previous section it was shown how the firm could utilize time savings and supply more of its retail outlets with its private fleet rather than having to use for-hire transportation. However, the firm does not necessarily have to utilize all of its time savings strictly in this manner, since there are other economically feasible means of using time savings.

One very significant way in which a private firm may utilize its time savings is through an extension of its area of influence or market area. Using the same amount of equipment, a firm benefiting from time savings may extend its market area by an amount equal to the distance traveled in the same time (which is equal to average speed on the improved highways times the amount of time saved). This extension of market area is possible at reduced costs and with the same amount of operating equipment. Since the firm may supply this extended market area at reduced costs, it may either take these reduced costs strictly in the form of profits or by reducing prices, sell more products (assuming more will be bought at lower prices) at reduced prices. Clearly, an economical decision would depend on the elasticity of demand and the economies of scale in any particular case. The firm's profits may be represented by the cost savings (the extra distance operated times the selected expenses not occurring on this additional mileage which is operated in the same amount of driving time with the same amount of equipment) and would also be determined by the demand conditions and economies of scale present in any particular case.

Figures 1 through 5 show the retail outlets of the large merchandising firm under consideration. All of the retail outlet locations shown are now served, at least par-

TABLE 13

SELECTED LINE-HAUL EXPENSES FOR LARGE MERCHANDISING FIRM OPERATING IN TEXAS, LOUISIANA, OKLAHOMA, AND NEW MEXICO PRIVATE FLEET RECORDS FOR YEAR ENDED DECEMBER 31, 1961

Expense	Selected Expense per Mile ($)	Line-Haul Percentage Allocated	Line-Haul Amount ($)
Drivers' wages	0.131506	100.00	0.131506
Workmens' compensation	0.000027	83.05	0.000022
Vehicle license and registration fees	0.008790	100.00	0.008790
Social security taxes	0.007846	19.72	0.001547
Total			0.141865

TABLE 14

VALUE OF TIME SAVINGS TO MERCHANDISING FIRM AT DIFFERENT SPEEDS

S_i (mph)	$\Delta E_t'$ ($)	H_s ($)	M_s ($)
39	10,764.14	5.4674	0.1401
40	21,648.00	5.6075	0.1401
41	32,531.86	5.7477	0.1401
42	43,415.72	5.8879	0.1401
43	54,299.58	6.0281	0.1401
44	65,183.44	6.1683	0.1401
45	76,067.31	6.3085	0.1401

tially, by the private fleet. Still other locations are served exclusively by common carrier. The light circular lines show the area within which the firm can now operate within designated layover-time distances. (Layover-time distances used here are defined most simply as the distance that can be driven in 10 hours.) The distance which may be traveled within a no-, one-, or two-layover period is determined by multiplying 10, 20, or 30 hours by the average speed for each region. The round trip distance traveled within any driving period is divided by two to determine the radius of market influence. The area of market extension, which may be served at reduced costs, is the area between the light and dark circular lines. The dark circular lines on the five maps are determined in a manner similar to the lighter lines; the dark lines merely represent a higher rate of speed (assumed to be 45 mph on the Interstate highways), whereas the lighter lines represent the average speed now being experienced in a particular operating region.

The foregoing relationship shows how a firm might choose to use its time savings in extending its market area and use the increased capacity of its private fleet to serve increased business. The firm may extend this area of influence by increasing the area as described, or it may simply increase the supply to the existing market area at reduced costs. Under conditions approaching pure competition, the former would have to be the more likely alternative, since in the absence of strong monopoly advantages, the firm would attempt to expand its operation to the point where marginal cost became equated with marginal revenue. This would mean, in effect, that a firm would continue to expand its area until the additional income derived from operating the last unit would be just equal to the additional costs incurred in its operation.

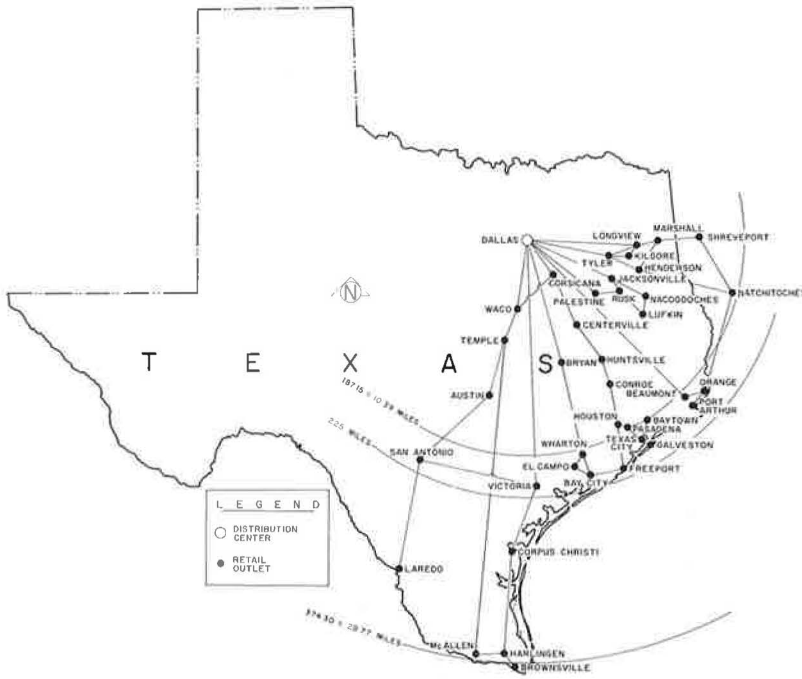

Figure 1. Existing and potential market area radius retail outlets of merchandising firm in east and south Texas.

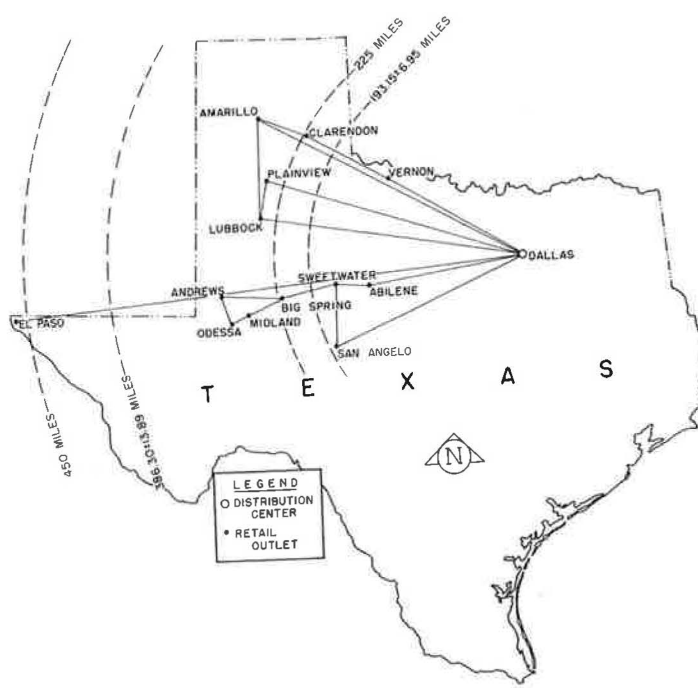

Figure 2. Existing and potential market area radius retail outlets of merchandising firm in north and west Texas.

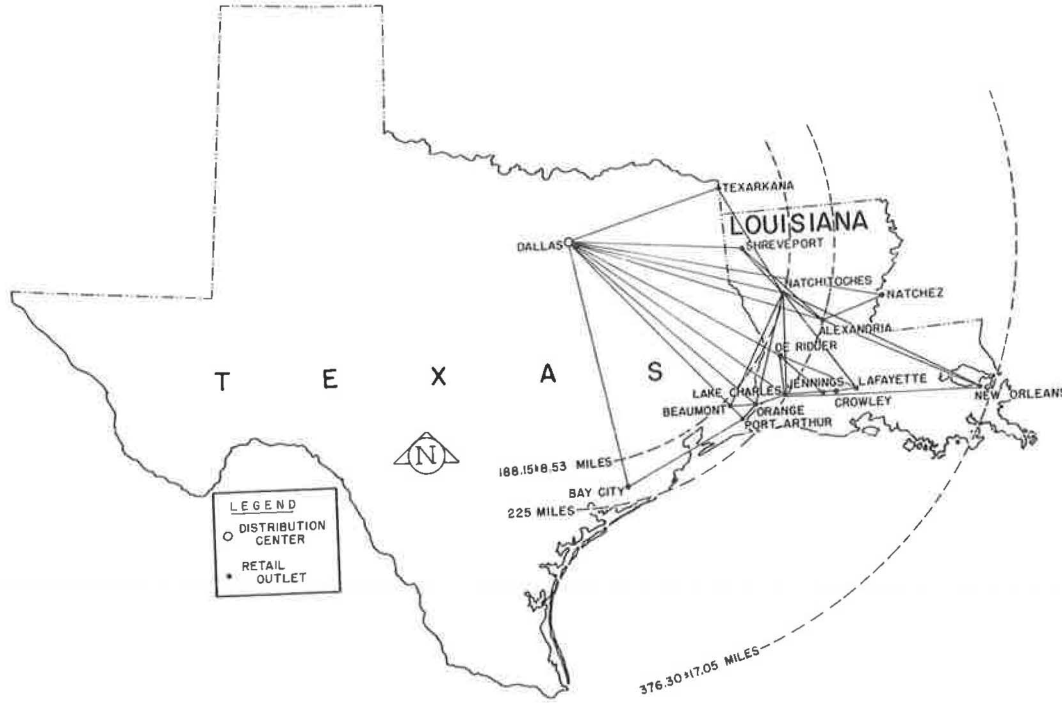

Figure 3. Existing and potential market area radius retail outlets of merchandising firm in Louisiana.

Market Area and Plant Location

Just as the market area served by the private fleet might be extended through increasing business in existing market areas, in some cases the market area served by the private fleet may be extended through new plant locations. These locations would be possible when time savings reduced costs to an extent where submarginal outlets became profitable.

The merchandising firm's marketing division determines the location of new retail outlets by determining the costs to serve a particular area and analyzing those factors which generally represent adequate demand, as shown by competitors, consumer purchasing power, etc. This firm has expanded its operations in the various regions to where all retail outlets now designated as profitable are served. Further expansion will be determined by whether either demand or costs change to an extent which will permit the location of new retail outlets. Such a possible change in costs could come through reduced transportation costs incurred in serving a particular location. In general, the total costs of the firm to supply a given product to a particular retail outlet is comprised of the costs of the product at the distribution center, the cost of transporting the product to the retail outlet (the distance from the distribution center to the retail outlet in miles times the transport costs per mile) and the costs of selling the good at the retail outlet. If the retail price that can be charged for the product is larger than total costs at a particular location, then this location is considered, from the cost situation, to be a suitable, profit-making location. Stated in more general terms, contemporary location theory states that if all costs other than transportation costs are constant, then location will be oriented toward points of minimum transport costs.

As was mentioned in the preceding analysis, Figures 1 through 5 show the various retail outlets served by the private trucking fleet of the firm under consideration.

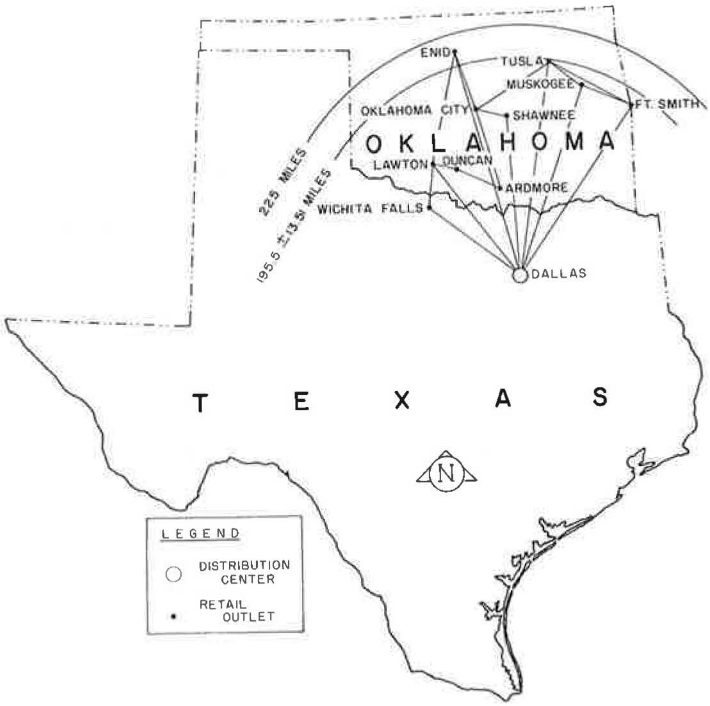

Figure 4. Existing and potential market area radius retail outlets of merchandising firm in Oklahoma.

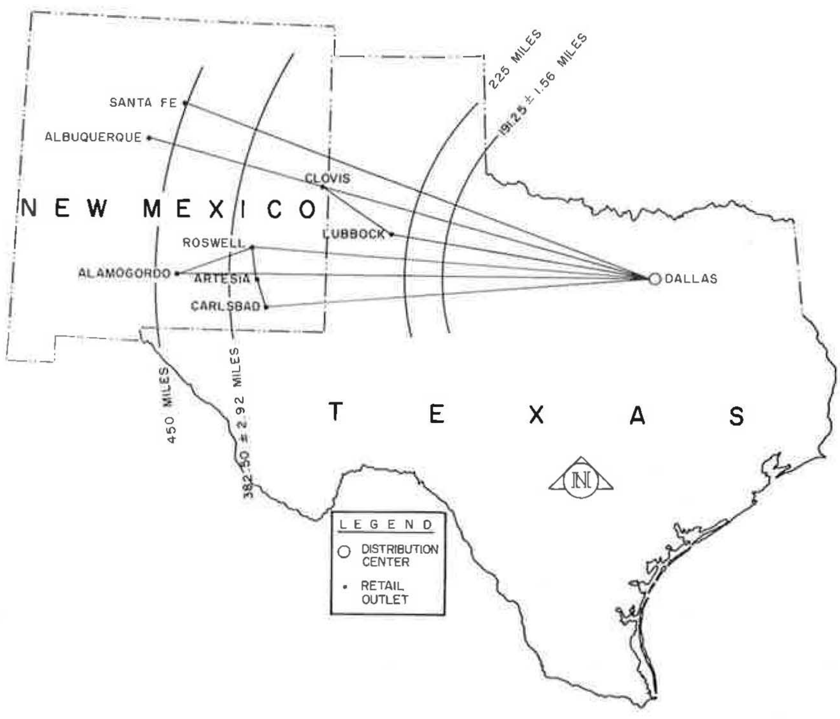

Figure 5. Existing and potential market area radius retail outlets of merchandising firm in New Mexico.

Also, it was shown how the firm might extend its market area served by private carriage through increasing the volume carried to existing stores. Other than the savings which would come from increasing the volume carried to existing stores, the firm might extend its market area by opening new outlets.

As was shown in the preceding analysis, time savings enable a firm to expand its operations at reduced costs. Whenever these costs are reduced enough to allow new retail outlet locations to become profitable, it may be said that the time savings take the value of the profits of these new outlets.

Clearly a variety of factors, many of which are somewhat intangible and have no readily assignable dollar value, must be taken into account in any decision on plant location. This report does not attempt to analyze all the various expenses of the potential retail outlets, but rather it outlines the conditions under which time savings might permit an extension of the market area of a firm.

ACKNOWLEDGMENTS

This paper is based on a study conducted by C. R. Haning and W. F. McFarland of the problems involved in determining the value of time saved to commercial motor vehicles through use of improved highways. The study was sponsored by the U. S. Bureau of Public Roads and was completed in 1963. A report was prepared and published in October 1963, as TTI Bulletin No. 23. The material in this paper was taken from that report.

REFERENCES

1. Aldrich, Lloyd. The Economy of Freeways. City of Los Angeles, Street and Parkway Design Division, June 1953.
2. Claffey, Paul J. Characteristics of Passenger Car Travel on Toll Roads and Comparable Free Roads. Highway Research Board Bull. 306, pp. 1-22, 1961.
3. Claffey, Paul J. Time and Fuel Consumption for Highway User Benefit Studies. Highway Research Board Bull. 276, pp. 20-34, 1960.
4. Fetter, Frank A. The Economic Law of Market Areas. Quarterly Jour. of Econ., Vol. 38, p. 525, May 1924.
5. Green, Forest H. The Value of Time Saved by Commercial Vehicles, as a Result of Highway Improvements. Unpublished report, U. S. Bureau of Public Roads, June 1960.
6. Hyson, C. D., and Hyson, W. P. The Economic Law of Market Areas. Quarterly Jour. of Econ., Vol. 64, p. 319, May 1950.
7. Isard, Walter. Location and Space Economy. Published jointly by Technology Press of Massachusetts Institute of Technology and John Wiley and Sons, Inc., New York and London, 1960.
8. Isard, Walter. Methods of Regional Analysis: An Introduction to Regional Science. Published jointly by Technology Press of Massachusetts Institute of Technology and John Wiley and Sons, Inc., New York and London, 1960.
9. Kent, Malcolm F. Fuel and Time Consumption Rates for Trucks in Freight Service. Highway Research Board Bull. 276, Jan. 1960.
10. Lang, A. S., and Robbins, D. H. A New Technique for Predicting Vehicle Operating Cost. Highway Research Board Bull. 308, pp. 19-35, 1962.
11. Lawton, Lawrence. Evaluating Highway Improvements on Mileage-and-Time-Cost Bases. Traffic Quarterly, pp. 102-125, Jan. 1950.
12. Saal, Carl C. Time and Gasoline Consumption in Motor Truck Operation. Highway Research Board Res. Rept. No. 9-A, 1950.
13. Sawhill, Roy B., and Firey, Joseph C. Motor Transport Fuel Consumption Rates and Travel Time. Highway Research Board Bull. 276, pp. 35-91, 1960.
14. Torgerson, Warren S. Theory and Methods of Scaling. New York, John Wiley and Sons, 1958.
15. Winfrey, Robley. Gasoline Consumption, Weight and Mileage of Commercial Vehicles. Highway Research Board Bull. 92, pp. 35-48, 1954.