AN INVESTIGATION OF THE FACTORS INHIBITING GROWTH OF CONTAINERIZATION IN DOMESTIC SURFACE FREIGHT SHIPMENTS

Thesis for the Degree of D. B. A.
MICHIGAN STATE UNIVERSITY
VERNON CHARLES SEGUIN
1971

Pg 67, 81,

ABSTRACT

AN INVESTIGATION OF THE FACTORS INHIBITING GROWTH OF CONTAINERIZATION IN DOMESTIC SURFACE FREIGHT SHIPMENTS

By

Vernon Charles Seguin

In this study containerization is defined as the integration of commodities into common [illegible] freight containers which are [illegible] handling systems they will [illegible] containers are 8 ft. x 8 [illegible] length from 20 to 40 fee[illegible]

Containerization [illegible] recently in overseas [illegible] are expected to handle [illegible] in this fashion within [illegible] container service accounts [illegible] carloadings today despite the [illegible] for domestic shipments way back in 19[illegible]. The literature abounds with projections and pronouncements concerning the factors which are inhibiting the growth of containerization in domestic surface freight shipments. This investigation seeks to determine the relative importance of these factors by asking the opinions of those who are actively engaged in the physical distribution of goods.

ABSTRACT

AN INVESTIGATION OF THE FACTORS INHIBITING GROWTH OF CONTAINERIZATION IN DOMESTIC SURFACE FREIGHT SHIPMENTS

By

Vernon Charles Seguin

In this study containerization is referred to as the integration of commodities into common denominator module freight containers which are compatible with the materials handling systems they will encounter. Nominal size freight containers are 8 ft. x 8 ft. in cross section and vary in length from 20 to 40 feet.

Containerization has experienced rapid growth recently in overseas shipments and some United States ports are expected to handle as much as 90 percent of their cargo in this fashion within the next few years. However, rail container service accounts for only about 0.5 percent of all carloadings today despite the fact that it was pioneered for domestic shipments way back in 1921. The literature abounds with projections and pronouncements concerning the factors which are inhibiting the growth of containerization in domestic surface freight shipments. This investigation seeks to determine the relative importance of these factors by asking the opinions of those who are actively engaged in the physical distribution of goods.

A questionnaire was developed in which respondents were requested to indicate the relative importance of 20 selected factors which are said to be inhibiting domestic containerization. A response of over 60 percent was obtained from 463 questionnaires mailed to representatives from the following business sectors: (1) freight users (durable and nondurable goods manufacturers, retailers, and freight forwarders), (2) freight carriers (motor, rail, marine, and air carriers and port authorities), and (3) container equipment suppliers. Replies were coded and subjected to statistical analysis in computer programs. Interviews were conducted with representatives of business and government to develop recommendations in light of the study findings.

Economic considerations which are listed as most important by all population sectors include, (1) rate structures which are inadequate to promote containerization and (2) the burden of empty container traffic. Shortages of containers and equipment, as well as the available alternative of TOFC (Trailer on Flatcar) piggyback are significantly more important to freight users than to the other groups. Conversely, coordinative matters, such as problems of divided carrier responsibility, are of less concern to freight users than to the others. Equipment suppliers see the lower available cube of containers, when compared to vans in over-the-road movement, as significantly less important than the users or carriers. All sectors ranked labor resistance as high in importance. However, from interviews it appears that this evaluation is influenced by difficulties with labor at the dockside involving foreign container shipments. None of the groups considers the influence of government as comparatively important in inhibiting growth of domestic containerization.

Questions were also asked concerning the containerization activities of the freight user respondents. Almost all of the freight users indicated that some or all of their goods is containerizable. Almost none own most or all of the containers that they use. There is a weak relationship between the use of containers by firms in foreign commerce and their use in domestic trade. However, there is no significant relationship between the use of TOFC piggyback and domestic containerization. Durable goods manufacturers use containers in domestic service significantly less than do nondurable goods manufacturers, retailers, or freight forwarders. The larger manufacturers are significantly greater users of containers in foreign trade than are their smaller counterparts. No important relationships can be developed when the freight user population is subdivided according to activity as shippers, consignees, combined shipper and consignees, or freight forwarders.

AN INVESTIGATION OF THE FACTORS INHIBITING GROWTH OF CONTAINERIZATION IN DOMESTIC SURFACE FREIGHT SHIPMENTS

By

Vernon Charles Seguin

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF BUSINESS ADMINISTRATION

Department of Marketing and Transportation
Administration

1971

This study is dedicated to those who seek additional encouragement to interrupt established careers in favor of further education. The rewards outweigh the sacrifices.

ACKNOWLEDGMENTS

A doctoral thesis begins with enrollment in the program, not with typing of the first page. Sincere appreciation is extended to the many persons who have contributed to the author's preparation for this culminating project. Particular thanks go to Dr. Thomas A. Staudt and Dr. Donald A. Taylor, successive Heads of the Department of Marketing and Transportation Administration, whose recommendations for fellowship assistance made possible my undivided attention to the program.

My gratitude to those who assisted in development of the thesis itself can only be inadequately recorded in words. Special thanks go to Dr. Donald J. Bowersox, committee chairman, who offered freely of his time and supervision. My appreciation is evident for Dr. Edward W. Smykay, committee member, who volunteered his services even though on sabbatical leave. My grateful acknowledgment goes to Dr. James W. Goff, committee member, who provided special insights gained from his long-time involvement in the study of product packaging.

Finally, to my wife, Jan, who was willing to leave a snug harbor to embark with me upon the uncharted seas of academia, I owe my lifetime thanks.

TABLE OF CONTENTS

LIST OF TABLES

Table		Page

Table		Page

Table		Page
49.	Multivariate and univariate tests of Hypothesis 5-B	295
50.	Contingency table for testing Hypothesis 6 . .	296
51.	Contingency table for testing Hypothesis 7 . .	297
52.	Contingency table for testing Hypothesis 8 . .	298
53.	Contingency table for testing Hypotheses 9 and 10--domestic shipments	299
54.	Contingency table for testing Hypotheses 9 and 10--foreign shipments	300
55.	Contingency table for testing Hypothesis 11--domestic shipments	301
56.	Contingency table for testing Hypothesis 11--foreign shipments	302
57.	Relationship between containerizability of goods and freight activity	303
58.	Mean values used to evaluate bias from Form I and Form II Questionnaires	304
59.	Mean values used to test for bias from first and follow-up mailings	305

CHAPTER I

INTRODUCTION

Scope of the Research

This study deals with the factors which are inhibiting the growth of containerization in domestic surface freight shipments. Expansion of containerization promises savings in physical distribution costs through reduction of losses from damage and pilferage as well as through improved efficiencies in intermodal transfers. Identification of the real as well as envisioned growth limiting factors is important for the development of programs to encourage greater participation by those concerned with domestic distribution of goods.

The literature presents a diversity of opinion concerning the relative importance of factors said to be inhibiting containerization growth. The vested interests of the various authors, relative to their professional activities, are hypothesized as being the primary cause of much of this divergence of opinion. In this research a questionnaire sent to a random sample of users, carriers, and equipment suppliers involved in freight movements was used to obtain opinions. The investigation includes their evaluation of the relative importance of twenty factors inhibiting containerization as developed in the literature. An examination of present containerization practices of freight users was also made.

Although intermodal transfers include all possible combinations of motor, rail, air, inland waterway and maritime carriers, this survey has been confined primarily to motor and rail operations. These two modes constitute the bulk of domestic shipments suitable for containerization. Rail and motor modes are also the major interface members with overseas shipments. While containerization in air cargos is currently experiencing significant growth, tonnages are still small when compared with surface movements. Further, the factors influencing the growth rate of containerization in motor/rail modes are expected to be likewise applicable to air transport movement.

In order to provide clarity, a few definitions are useful. Containerization is referred to as the integration of commodities into common denominator module freight containers which are compatible with the materials handling systems they will encounter.[1] Tabak's definition of a freight container is used as a guideline in this study.[2] He states,

> A freight container is an article of transport equipment: a) of a permanent character and accordingly strong enough to be suitable for repeated use; b) especially designed to facilitate the carriage of goods, by one or more modes

> of transport, without intermediate reloading; c) fitted with devices permitting its ready handling, particularly its transfer from one mode of transport to another; d) so designed to be easy to fill and empty. . . .

Tabak defined a freight container as having an internal volume of at least one cubic meter (35.3 cubic feet), but this small size is limited primarily to use on aircraft. The nominal size in use today is 8 ft. x 8 ft. in cross section, by 20 feet long (1,280 cubic feet). Van size containers which are 40 feet long are growing in popularity. Highway trailers could also be considered as meeting the freight container definition given above since they are used in intermodal transfers on rail flatcars and in "roll-on/roll-off" movements on ocean-going vessels. However, they are not included in the "container" category by transport trade. Containers are sometimes referred to as "wheeless containers" to emphasize their difference from highway trailer vans.

Present State of Container Practices

Containerization of international shipments has experienced dramatic growth over the past 10 years. Continued rapid expansion of overseas containerization is projected for the future. In 1970, at least one containership is expected to sail from North Atlantic ports of the United States daily. These sailings will provide a shipping capacity of 220,000 twenty-foot containers a year.[3] By 1975, the Elizabeth, New Jersey terminal of the Port Authority of New York expects that the projected nine million annual tons of cargo it will handle will be 90 percent containerized.[4] Japan's Transport Ministry predicts that by 1973 as much as 85 percent of that year's 2.6 million tons projected Japan-California freight will be containerizable.[5] Increased containerization has benefitted overseas shippers through reduced labor costs. Decreased time delays in dockside transfers of goods, less damage to merchandise, and lower pilferage rates have also been obtained.

Despite such recognized and demonstrated benefits in overseas shipments, containerization has lagged in domestic freight shipments. The major accomplishment of integrated transfers in domestic shipments has been piggyback operations. These have recently been divided approximately 90 percent trailer-on-flatcar (TOFC) and 10 percent container-on-flatcar (COFC). The TOFC/COFC carloadings rose from 417,000 in 1959 to 1,337,000 in 1968. However, piggyback service increased less than 1 percent further to 1,344,000 carloadings in 1969.[6] In total, TOFC accounted for 4.8 percent of the 1969 carloadings. COFC, in comparison, was insignificant in accounting for less than 0.5 percent of total carloadings.

Statement of the Problem

The literature on containerization has expanded rapidly in the last few years. There are a number of periodicals devoted exclusively to the field and many physical distribution magazines regularly carry special issues on the subject. Proceedings are frequently reported covering meetings of various organizations concerned with promoting development of containerization.

For purposes of organization, statements in the literature relating to lagging domestic containerization can roughly be categorized into five areas of concern. These areas are not mutually exclusive since economic considerations can be read into almost any comment, but the following classification provides a useful basis for analysis:

1. Economic reasons
2. Container equipment availability
3. Coordinative activities
4. Labor resistance
5. Governmental regulation and influence.

<u>The problem of this investigation</u> is the development of a <u>list of factors which are inhibiting growth of domestic containerization</u>. The list of factors must be arranged <u>in ordered sequence of relative importance</u> so as to provide useful guidance for programs to promote more effective use of containers.

A number of difficulties are confronted in attempting to develop an ordered listing of inhibiting factors. First, there is considerably diversity of opinion as to the items in the list of influencing factors and as to their relative importance. Second, opinion is subjective and not readily quantified for scientific analysis. Third, those who offer opinions have diverse backgrounds and their attitudes must be related to the requirements of the sectors that they represent. Finally, the evaluations must be gathered from qualified authorities who are scattered across the country.

Methodology

The general methodology summarized below includes the development of a questionnaire and its distribution to a randomly chosen sample. The sample design provides for adequate representation from recognized strata in the population. Questionnaire replies were used to test eleven hypotheses. Follow-up interviews were conducted to help develop conclusions in the light of questionnaire replies.

The Questionnaire

The primary research instrument in this study is a questionnaire which was mailed to a sample of 464 people who are involved in activities related to the movement of freight. A copy of the questionnaire which contains four groups of questions is included in Appendix A.

The first group of questions consists of twenty factors which have been mentioned in the literature as being responsible for inhibiting the growth of containerization in domestic freight shipments. In order to develop quantifiable relationships from subjective evaluations, respondents were asked to indicate their opinion concerning the relative importance of each factor by marking a numerical rating scale. The scale consists of the following equal-appearing intervals:

1. Extremely important
2. Quite important
3. Medium importance
4. Not very important
5. Almost no importance.

Five questions comprise the second group of questions. They were designed to develop relationships in present container practices. Respondents who are Freight Users were asked for a Yes/No reply to questions concerning their use of (1) domestic containerization, (2) foreign freight containerization, and (3) TOFC piggyback. They were also asked about their ownership of containers and whether some of the goods they shipped were considered containerizable.

The third group of questions was used to categorize respondents as to their type of business, freight activity, and the relative size of their firm.

Finally, an open-ended question was presented to cover points not included in the questionnaire.

The Sample

A random sample was structured from the following sectors of the surveyed population:

1. Freight Users--durable and nondurable goods manufacturers, retailers, and freight forwarders.
2. Freight Carriers--motor, rail, marine, and air carriers, and port authorities.
3. Containerization Equipment Suppliers.

Methods of Analysis

Eleven hypotheses were developed relating to the contents of the questionnaire. The hypotheses, presented in the null form, are abstracted below.

Hypothesis 1: There is no statistically significant difference in the relative importance of factors inhibiting growth of domestic surface freight containerization, as evaluated by representatives of the following sectors: (1) potential or actual users, (2) carriers, or (3) containerization equipment suppliers.

Hypothesis 2: There is no statistically significant difference in the relative importance of factors inhibiting growth of domestic surface freight containerization, based upon collective evaluations of the following sectors of the freight user population: (1) durable goods manufacturers, (2) nondurable goods manufacturers, (3) retailers, or (4) freight forwarders.

Hypothesis 3: There is no statistically significant difference in the relative importance of factors inhibiting growth of containerization in domestic surface freight shipments, based upon collective evaluations of representatives of larger and smaller firms in the freight user population.

Hypothesis 4: There is no statistically significant difference in the relative importance of factors inhibiting growth of containerization in domestic surface freight shipments, as viewed by representatives of the freight user population, segregated according to their activity as (1) shippers, (2) consignees, (3) shipper and consignees, or (4) freight forwarders.

Hypothesis 5: There is no statistically significant difference in the relative importance of factors inhibiting growth of domestic surface freight containerization, based upon the collective evaluations of the freight carrier population in the following segments: (1) motor, (2) rail, (3) marine, (4) air, or (5) port authorities.

Hypothesis 6: There is a statistically significant relationship between the use of containerization by firms in foreign shipments and their use of containerization in domestic shipments.

<u>Hypothesis 7</u>: There is a statistically significant relationship between the use of TOFC (Trailer On Flatcar) piggyback by firms and their use of containerization in domestic shipments.

<u>Hypothesis 8</u>: There is a statistically significant relationship between ownership of containers by firms and their practice of containerization in either foreign or domestic shipments.

<u>Hypothesis 9</u>: There is a statistically significant relationship between the type of business and use of containers in domestic or foreign service by freight users.

<u>Hypothesis 10</u>: There is a statistically significant relationship between the size of business and use of containers in domestic or foreign service by freight users.

<u>Hypothesis 11</u>: There is a statistically significant relationship between the type of freight user activity (shipper, consignee, shipper and consignee, or forwarder) and use of containers in foreign or domestic service.

Hypotheses 1 through 5 were subjected to two different methods of statistical analysis. The mean values of measure from the numerical rating scale of importance for each of the twenty factors were used. A ranking of the composite evaluation for each population sector was developed. Kendall's coefficient of concordance, W, was calculated from the rankings being compared and a chi-square statistic was derived in order to test the given hypothesis.[7] A multivariate analysis of variance test was also applied to the same hypotheses in order to indicate the significance of differences of opinion concerning the level of importance of the individual factors.

Hypotheses 6 through 11 were tested by chi-square analysis of contingency tables developed from replies to questions concerning present containerization practices.

The facilities of the Michigan State University Computer Laboratory were used in analyzing questionnaire replies. Programs developed by the Computer Institute for Social Science Research (CISSR) and the Schoool for Advanced Studies of the College of Education were used in testing the hypotheses.

The Interviews

To supplement questionnaire responses personal interviews were conducted with representatives of business, trade organizations, and government. The interviews were held after correlation of the questionnaire results. Interviewees were advised of the questionnaire findings and were asked to suggest approaches to obtaining increased application of containerization to domestic freight. A copy of the interview outline is also included in Appendix A.

Organization of the Thesis

The thesis is organized into six chapters, including this Chapter I, which provides an introductory overview of the study. A literature review is contained in the next two chapters. In Chapter II the fundamentals of intermodalism and the history of containerization and piggyback movements are traced. The technology relating to containers and handling equipment is also reviewed.

The factors which have been reported by various speakers and writers as being responsible for the lag in containerization of domestic freight are presented in Chapter III. Information contained in this section of the thesis was used in developing the factor questions in the research questionnaire.

The methodology of research is evolved in Chapter IV. Matters considered in development of the hypotheses and determination of the size and nature of the population sample are reviewed. The rationale of the program for statistical testing of the hypotheses is explained.

The results of the research are reported in Chapter V. These include the tests of the hypotheses and summaries of replies to open-ended questions. In addition, tests for biases which might have resulted from the methods used in administering the questionnaire are also considered. Recommendations for further work include an indicated need for additional research on the economics of containerization.

More active participation by both government and industry in promoting and coordinating the practice are suggested.

Copies of the instruments used in collecting the data are contained in Appendix A. Tabulations of data used in the testing of hypotheses are assembled in Appendix B. A condensation of replies to the interview questions is presented in Appendix C.

CHAPTER I--FOOTNOTES

[1] Ralph E. Sims, Planning and Managing Material Flow (Boston: Industrial Education Institute, 1968), p. 367.

[2] Herman D. Tabak, Cargo Containers--Their Stowage, Handling, and Movement (Cambridge, Maryland: Cornell Maritime Press, 1970), p. 5.

[3] "Export Is the Name of the Game," Distribution Manager, June, 1968, p. 36.

[4] "The Port Terminals--A New and Expanded Role," Distribution Manager, October, 1968, p. 52.

[5] "Container Potential Up," Distribution Manager, June, 1968, p. 28.

[6] Burton N. Behling, "1969 Review," Railway Age, January 19, 1970, p. 54.

[7] For development of the Kendall coefficient of concordance, W, see Sidney Siegel, Nonparametric Statistics for the Behavioral Sciences (New York: McGraw-Hill Book Co., 1956), pp. 229-238.

CHAPTER II

REVIEW OF LITERATURE--I

Background for Containerization

> It has been said that so much has been written and published about containers, their advantages, disadvantages, shapes, sizes and economics that it would take a man all his working life to read it. It has also been stated recently that so much is now happening with containers throughout the world that it would take a fairly sophisticated information storage and retrieval system to keep the information current.
>
> . . . 1969 has seen the true start of the "Container Age." Many ships, port installations and inland transport facilities planned and constructed over the past three or four years have come into service and many more will be completed and operating by the end of 1970. From now on theories talked about for so long will have to be made to work and the initial practical difficulties which face the intermodal movement of cargo through different transport media from producer to consumer will have to be ironed out, as they do with any new system which is introduced.
>
> (Foreword to *Jane's Freight Containers*)[1]

The purpose of this first section of the literature review is to develop for the reader a general understanding and background of containerization as practiced in domestic freight shipments. The background material has been selectively chosen to aid in considering the factors which are inhibiting the growth of containerization in domestic surface shipments.

The Concept of Intermodalism

According to one writer,[2] containerization could afford the basis for completely integrated, worldwide door-to-door transportation if perfected and advanced to the ultimate extent of its potential usefulness. He envisions all-purpose equipment which would be interchangeable in rail, highway, water and air transport. Achievement of an integrated transport system requires the complete coordination of the total physical plant, abetted by compatible governmental policy and managerial philosophy. This section considers the broad concept of intermodalism as the basis of an integrated transport system.

A discussion of modal systems which allow an interchange of cargo units includes rail, highway, water and air routes, but omits pipelines as incompatible to the process. Interchange is desirable between modes in order to take advantage of their respective favorable factors. Interchange within modes (intramodalism) is necessary when the initial and final points for a freight movement are not limited to the boundaries of a single carrier. A comparison of the relative desirabilities for the modes under consideration is presented in Table 1 below.[3]

Table 1. Comparative ratings of transportation modes[a]

Characteristics	Rail	Highway	Air	Water
Speed:				
Under 500 miles	3	1	2	4
Over 500 miles	2	3	1	4
Versatility	2	3	4	1
Capacity	2	4	3	1
General availability	2	1	3	4
Reliability or dependability	2	1	3	4
Frequency/continuity of service	3	1	2	4
Surge or peak handling capacity	1	2	3	4

[a]1 = most desirable.

The numbers in the table are somewhat arbitrary and are subject to modification with changing technology. Cost of service depends upon such factors as the type of goods, the size of shipment, distance of shipment, and auxiliary services such as need for refrigeration, pick up and delivery and special in-route services. All things being equal, cost comparisons between modes vary directly with the speed of service.

Modal Combinations

The various combinations of modal services which have been practiced over the years are presented below in a matrix form as Table 2.

Table 2. Modal transfers for combination service

Mode	Rail	Highway	Air	Water
Rail	Intramodal			
Highway	TOFC/COFC Piggyback	Intramodal		
Air	...	Air-Truck Air-Bus	Intramodal	
Water	Train-ship	Roll-On/Roll-Off Fishyback	...	Intramodal

In terms of numbers, the most important transfers in domestic freight movements are the intramodal shifts. Each of the major modes developed and improved its carrying units to maximize their usefulness in accordance with the physical characteristics of its system. For example, rail boxcars are designed to be interchangeable on standard gauge tracks across the country. Highway trailers can be hauled interchangeably on motor tractors. For the most part, inland waterway barges can be moved in mixed tows. In the case of air shipments, development of standardized containers is now allowing greater freedom in intramodal shipments. The specialization for maximum utility within the mode resulted in incompatibility between the modes, with the resultant requirement of manual labor for transfer of cargos between carrying units. This was followed by the development of adapter units (for example, placing rails on ferryboats to

allow water transfer of rail cars). Finally, the evolution of the cargo container is providing the means for bridging the incompatibility of the various modal carrying units.

Rail-Highway

In domestic *inter*modal movements, the rail-highway Trailer On Flatcar/Container On Flatcar (TOFC/COFC) shifts are most important in terms of numbers, with the TOFC portion accounting for about 90 percent of piggyback traffic. The development and characteristics of piggyback and containerization are of sufficient importance to this study that they justify independent treatment in a later section of this chapter.

Rail-Water

For rail-water transfers, boxcars were rolled onto ships equipped with rails in ferry service on Lake Michigan as far back as 1892.[4] Since that time the practice has expanded to the use of ocean-going vessels more than 400 feet long and capable of carrying over 100 loaded freight cars. Special loading facilities were installed at each port served, consisting of elevators capable of lifting loaded boxcars and positioning them over the hold of the trainship. With the advent of the 20 foot and longer container designed for ocean travel, demand for trainship movement began to decline in favor of containerships. In comparison, containers can be handled easier and quicker at dockside and do not require the waste space occupied by rail

car undercarriage. In addition, the containers can be transferred to a motor carrier at the destination port for rapid final delivery, whereas trainship is limited to rail transfer at each end of the trip.

Highway-Water

A comparatively recent innovation in highway-water transfers is roll-on/roll-off "fishyback"; also referred to as "RoRo." The largest ship designed for this service has been operating for over two years on a weekly run between New York and San Juan, Puerto Rico.[5] The vessel can carry 240 highway trailers as part of a 500 total vehicle mix. The major advantage claimed is total flexibility for handling anything that can be rolled aboard. There is no need to be limited to standard sizes as is the case with containers. Using multiple port openings, the ship loads and unloads at the rate of one trailer on and one trailer off every two minutes. Turnaround time at the docks averages about 12 hours. About 20 percent of the ship's cargo comes directly from piggyback trains and the percentage has been growing, with a 40 percent share expected in the future. A more recent development is the combined roll-on/roll-off containership. Vessels are available with a capacity for 824 standard 20 foot containers, plus a lower deck load of miscellaneous rolled-on vehicles, and are designed to operate at 24 knots on the high seas.

Included in water service are the barge lines that operate on the navigable rivers and intracoastal waterways. A few barge lines have joint routes with rail and truck connections, but since this mode is most advantageously used in bulk commodity shipments, the business is primarily port-to-port.

Highway-Air

Since airports are generally located on the fringes of urban centers, air carriers must interface with motor freight service to provide door-to-door coverage. Coordinated service agreements have been established, including those in which a single bill of lading is used. In order to serve smaller communities not provided with direct air freight connections, air-bus package express service is provided to about 6,000 communities. Shippers can use bus service to deliver packages to the nearest airport and bus transfer can also be used to deliver from the final port to the consignee.

Relative Importance of the Modes

The relative importance of the various modes in domestic freight movements can be evaluated in terms of activity, generally measured in ton miles, or total revenues. There are discrepancies in the numbers available, depending upon the sources of information, but the numbers presented in the tables below are adequate for demonstration of relative importance.[6]

Table 3. Ton mile distribution among intercity carriers

	Millions Ton Miles		Percent of Total	
	1966	1980[a]	1966	1980[a]
Railroad	750,800	1,025,569	43.0	34.4
Motor carrier	380,917	737,623	21.8	24.8
Inland water	280,000	487,335	16.0	16.4
Pipeline	332,900	709,625	19.1	23.8
Air	2,250	18,138	0.1	0.6
All modes	1,746,867	2,978,290	100.0	100.0

[a]Projection.

The selective transport by air and motor carriers of higher value goods which justify payment of higher freight rates is reflected in Table 4.[7]

Table 4. Revenue distribution among regulated carriers

	Percent of Total	
	1966	1980[a]
Railroad	43.6	28.8
Motor carrier	48.5	61.2
Inland water	1.5	1.0
Pipeline	4.2	4.0
Air	2.2	5.0
All modes	100.0	100.0

Both in terms of ton miles moved and in revenue generated, the railroad and motor carrier modes are the most important participants in domestic shipments and this situation is projected to continue into 1980. Intramodal and intermodal transfers between these two modes represent the major potential for containerization growth in domestic shipments. The emphasis of this paper is directed to these two modes. There is currently a growing interest in application of containerization to air cargo traffic, but as noted in Tables 3 and 4, total volume and revenues are a minor factor in domestic movements.

Relative Importance of Foreign Shipments

Although the current major interest and activity in containerization relates to foreign shipments, this study is primarily concerned with domestic movements. The volume of freight moved in domestic traffic is much larger than that in foreign trade, and containerization is already well developed in the latter area. Directly comparable numbers are not readily available since domestic freight is usually reported in ton-miles, while foreign trade is given in tons or value of shipments. However, if a generous average 1,000 miles per shipment is used for foreign movements for purposes of comparison, the numbers would look somewhat like those given in Table 5 below.[8]

Table 5. Foreign versus domestic freight volume, 1966

	Millions Ton Miles	
	Domestic	Foreign
Railroad	750,800	NA
Motor carrier	380,917	NA
Air	2,250	366
Marine	---	452,052
Total accounted for	1,133,967	452,418

The numbers on U.S.-foreign surface trade are not readily available, but would include primarily Canada and Mexico. Recent statistics indicate that these would add no more than 100 million ton miles to the foreign total. Therefore, it can be seen that foreign shipments comprise only about one-half of those of domestic movements in the modes that are primary targets for containerization; namely, rail, motor carrier, marine, and air. Nevertheless, marine shipments in foreign trade have been the locus for the recent growth of containerized traffic.

The discussion thus far has been intended to place the various modes in proper perspective with respect to their relative importance in national freight activity. Effective coordination of the modes would allow the transfer of goods from one system to another at minimum cost in time and money. The objective is to use the technologies of two or more systems to achieve an optimum through movement of freight. Implementation of coordinated service must be

carried out by the carriers involved and containers are a necessary tool for bridging modal interface barriers.

Benefits of Containerization

Most of the benefits of containerization derive from a simple concept: if you put something in a container you can both protect it and make it easier to handle. Benefits of the practice accrue to both the shipper and the carrier. The opportunity for savings is highlighted by a former transportation analyst with Fruehauf Trailer Company, who pointed out that one-half the cost of transporting domestic goods is spent in shuffling between vehicles, across docks and platforms, in packaging, loss and damage claims, pilferage, and insurance.[9]

Reduction in Claims Due to Damage and Theft

Containerization eliminates much of the extra handling costs and thereby reduces likelihood of damage and loss from pilferage. A measure of the reduction in claims costs through containerization is presented in estimates developed by the National Academy of Sciences, based upon published ICC data for truck and rail cargo during 1960.[10] The figures for inland claims per measurement ton of cargo include loss and damage expenses, claim payments and related clerical costs. Damage claims and loss and pilferage claims were each responsible for about 50 percent of break-bulk cargo

losses. Containerization was estimated to reduce damage claims by about 50 percent and almost completely eliminate pilferage claims. The numbers are presented in Table 6 below.

Table 6. Cargo claims: unit load vs. break-bulk systems

	Dollars per Measurement Ton	
Load Type	Truck	Rail
Break-bulk	0.16	0.26
Containers	0.04	0.07
Pallets	0.08	0.13

Some idea of the potential for loss reduction through containerization is apparent from the fact that in 1963 the combined claims paid by rail and motor carriers were $226 million. Furthermore, the total cost of claims is estimated at five times the actual claim dollars paid out.[11] In 1969 clothing accounted for better than 10 percent of total claims paid on motor carrier losses, and this was followed by household appliances at 6 percent.[12] In contrast, the protection afforded by containers is demonstrated by a speaker who stated that claims were reported on less than 1 percent of 12,000 containers shipped over a recent three year period.[13] A rail carrier representative stated that claims on containerized cargos over the past few years were averaging about 10 percent of conventional break-bulk loadings.

Packaging Costs

Savings in packaging costs are not always as readily available for foreign containerized shipments as for domestic consignments. In the former the possibility frequently exists that the contents may not move door-to-door in the same container because of labor agreements, customs inspections, and errors in documentation. On the other hand, containerization allows the use of lighter packaging in domestic trade if the cargo is properly stowed so as to avoid shifting of the load. Estimates based upon data provided by such shippers as the General Services Administration were prepared by the National Academy of Sciences and are presented in Table 7.[14] Not included in the table

Table 7. Packaging costs: unit load vs. break-bulk

Load Type	Type of Packaging	Packaging Cost[a]
Break-bulk	Export pack	32.00
Containers	Domestic pack	20.00
Pallets	Domestic pack & sheathing	22.54

[a]Dollars per measurement ton.

are the savings from reduced tare weight due to lighter packaging, as well as reduced cube. The adjustment of packaging to containerized shipments is best subjected to a systems analysis, wherein the savings from packaging are balanced against the risk of damage to goods in transit. Although primarily concerned with import traffic, Mattel, Inc. reported containers removed the need for all-weather packaging required for cargo stowed loose, and a reduction in damage to goods was also realized.[15] They were also able to negotiate favorable volume commodity rates on the inland portion of their import movements because the use of van containers made it more economical to handle the goods from the harbor to their plants.

<u>Additional Benefits to Shippers</u>

The experience of Mattel, Inc. demonstrates additional benefits through the use of containers (primarily in import shipments, but not necessarily limited to this area). Reductions in door-to-door transit time of two to three extra work days were obtained, mainly because of elimination of the need for unloading, sorting, and reloading loose cartons on trucks. Containers could also be loaded aboard rail flatcars on the west coast for movement eastward within 24 hours of arrival at the piers. Priorities in handling specific containers can be arranged through billings which indicate container numbers and code numbers of contents.

By loading the container in the plant and then transferring it directly to an over-the-road truck, city pickups can be eliminated at each end of the trip. The box can be used for temporary storage at either end, free from the likelihood of damage, contamination, or pilferage. For extended storage, containers meeting ISA specifications are capable of being stacked as many as six high. The benefits of minimum handling and storage under proper conditions are particularly important in the shipment of fresh produce in refrigerated containers. A citrus fruit shipper testified that switching to containers provided longer shelf life for the goods and higher market prices.[16]

The benefits of containerization are readily apparent to the Department of Defense, which has pioneered in the development, particularly with the CONEX container in the early 1950's. (The CONEX container is roughly a seven foot metal cube that holds five tons of cargo.) It has been estimated that full application of containerization to the Vietnam operation would have saved over $1 billion in transport costs, losses in shipment and storage, and in packaging costs. Required logistical personnel would have been reduced and there would have been increased efficiency and faster deployment of goods.[17] The Department is now engaged in the development of a containerized logistics distribution system and has undertaken development operations such as the containerized shipment of ammunition. Intermodal innovations

include the use of helicopters for unloading goods in ports where dock facilities are unavailable or too congested.

Benefits of Containers Over
Trailers in Piggyback Service

Many of the benefits of containerization for shippers also accrue to the carriers. For example, reduced handling means faster turnaround of equipment; less dead time at the docks and rail sidings. There are also benefits mainly for the carriers and a goodly share of them are brought out in frequent arguments concerning COFC versus TOFC piggyback. Some years ago a consulting engineer presented a list of advantages of COFC that would eventually allow it to displace TOFC. His predictions have not materialized but the factors he presented are still valid.[18] They include the following:

1. Standard van containers or flat cars are within railroad clearance regulations and do not require selective routing sometimes necessary for semi-trailers on flat cars.
2. Van containers can be positively secured to flat cars and highway chassis with a minimum of attachments.
3. Loading or unloading of van containers from flat cars with cranes or fork trucks can be done randomly and more quickly than the roll-on, roll-off type end loading of trailers.
4. Van containers are lighter in tare weight than semi-trailers of similar capacity.
5. Van containers represent a lower investment than semi-trailers of similar capacity.
6. Flat container cars are smaller, lighter and cheaper than corresponding TOFC cars.

With reference to the last item noted, a consultant from A. T. Kearney Co. estimated that special freight trains using lightweight flatcars and containers can save as much as one million ton-miles per day in deadweight as compared to conventional TOFC trains.[19] With the higher center of gravity for the conventional piggyback trailer, the load is subject to more damage from jars and jolts of rail haulage. Lower wind resistance of COFC trains allows for higher speeds.

With trailers, the cost of license plates, tax plates, tires (more than $2,300 worth on over-the-road trailers), bogies, etc., are tied up on a TOFC load, whereas they can be kept in revenue service when used with a demountable container. There is less exposure to vandalism for a container attached to a flatcar, as compared to a pneumatic-tired trailer van lashed to the car. One final factor offered is that the wide variety of liquid carrying containers offers the Railroads trucklines greater flexibility of service and does not require dead-head time for unloading, since the container can be dropped off for use directly on the production line.

History of Piggyback

Domestic Development

The histories of container and trailer piggyback are intertwined in a general concept of containerization and intermodal transfers. The container principle was first

recorded by James Anderson, an Englishman, in 1801. In 1834, the state-owned Main Line of Public Works in Pennsylvania began rail shipment of canal boats in detachable sections without breaking bulk between Philadelphia and Pittsburgh; this service was maintained until 1857. Just prior to 1850 the Pennsylvania Railroad began using containers for transporting passengers' baggage.[20] For a several year period beginning in 1885, the Long Island Railroad Company operated a "Farmer's Train" between Long Island points and the East River, carrying four loaded produce wagons per flatcar, with the teams riding along on the same train in specially provided box cars.[21]

The New York Central pioneered present day type container service, which it began in March, 1921, between Cleveland and Chicago. The Boston and Maine established rates on containers over points on its lines in March, 1927. The Lehigh Valley followed with offerings in 1928. The Pennsylvania first offered container rates over three routes in 1928 and soon added additional routes. By 1931, the three above mentioned lines had petitioned to extend the service to principal points in their territories.[22]

As an example, the rate established by Boston and Maine covered "miscellaneous less-than-carload shipments, rated not lower than fourth class--when loaded into steel and wood containers, the outside dimensions of which must be seven (7) feet in length, eight (8) feet in width, and seven (7) feet in height." The service, in this case, was

established to accommodate a forwarding company which owned the containers, loaded and unloaded them, and was desirous of switching from an electric rail line which it had been using.[23]

The first trailer-on-flatcar service was instituted by the Chicago North Shore and Milwaukee Railway in 1926 between Chicago, Illinois and Milwaukee, Wisconsin. The railroad used 16-foot highway trailers for operation over city streets for pickup of less-than-carload shipments at the door of the shipper. The trailers were loaded three to a flatcar for the rail journey, and then the goods were subsequently delivered by trailer to the destination. The service was discontinued in 1947.[24] During the 1930's and 1940's various similar operations were conducted by several other railroads with varying degrees of success. For example, in 1932 the North Shore invited over-the-road carriers to ship semi-trailers by train between Chicago and Milwaukee at a rate a little lower than what it would cost to move the same trailer over the highway. The railroads experimented with several rate bases and discovered that rates on a per-mile basis with a maximum charge per container were the most practical basis. This basis was litigated before the ICC, who issued a new formula based upon classification of freight in the containers. The rates were not attractive to shippers and this resulted in the end of container service for that period[25] (ICC Docket No. 21723 referenced as footnote 22).

In 1936 the Great Western began transporting highway trailers between Chicago and St. Paul, using a basic rate per loaded trailer, open to the general public. The trailers were loaded aboard flatcars by the shippers, two to a flatcar, and were returned empty at half the full trailer charge. The New Haven instituted TOFC operations in 1937 under an open tariff in which motor common carriers reserve the right to substitute TOFC service for highway transportation. The railroad was compensated according to a published schedule. Over 50,000 trailers were transported by the New Haven under this plan in 1953.[26]

Over the subsequent years a number of piggyback plans have been developed. These apply equally to trailers or containers carried on flatcars. The basic plans are described in Table 8 following.[27] The plans developed more or less in chronological order, with Plan I initiated by the Great Western as described above. Plan II came into service in 1955, Plan III in 1956, Plan IV and Plan V in 1958. Plan II½ was initiated in 1964 by the Missouri Pacific Railroad.[28] A discussion of the relative advantages to the shippers, motor carriers, and railroads is deferred to a later section dealing with rates.

Development of piggyback service from the experimental stage to its present scale occurred largely in the decade following the ICC decision in 1954 which clarified an accumulation of issues concerning the practice (ICC

Table 8. Piggyback plans

Plan	Originator	Who Supplies Equipment and Transfer	Who Delivers and Picks Up	Basis of Rate
I	Motor carrier	Motor carrier; motor carrier loads and unloads trailer on railcar; rail carrier furnishes flatcars	Motor carrier	Motor carrier rates; blanket divisional basis for all freight in the vehicle (not on individual articles)
II	Rail carrier	Rail carrier	Rail carrier	Railroad commodity rates
II½	Rail carrier	Rail carrier; consignor and consignee load and unload trailers and move them between ramp sites and warehouses	Consignor and consignee	Flat rate; 60 percent rule applies
III	Shipper or forwarder	Shipper or forwarder furnishes trailer (owned or leased); railroad furnishes flatcars, and rail carrier loads and unloads trailers	Shipper or forwarder	Flat rate; 60 percent rule applies
IV	Shipper or forwarder	Shipper or forwarder furnishes flatcar and trailer	Shipper or forwarder	Flat rate; 60 percent rule applies
V	Motor carrier	Motor carrier	Motor carrier	Rail carrier tariff for joint motor-rail rates

Docket 31375 referenced as footnote 21). The record of growth for selected years is given in Table 9 below.[29]

Table 9. Piggyback carloadings

Year		Year	
1955	168,150	1967	1,207,242
1959	416,508	1968	1,337,000
1964	890,748	1969	1,344,000

The relative importance of the various plans is illustrated in Table 10 below.[30] It should be noted that the number of trailers and containers listed in 1968 is greater than the number of carloadings shown in Table 9. This is because more than one trailer or container can be loaded on a flatcar.

There were 59 railroads participating in piggyback service in 1965. There was substantial concentration of operations in a few railroads, with five of them accounting for 41 percent of the total shipments. The majority of piggyback terminations moved in local service, with waybill samples indicating that 86 percent of the traffic originated and terminated in the same territory; i.e., official, southern, and western. The average local haul was 589 miles and for inter-line service was 929 miles. Ten states accounted

Table 10. Trailers and containers terminated by Class I railroads, 1968

Plan	Terminations (thousands)
Plan I	276.0
Plan II	657.6
Plan II½	462.5
Plan III	169.3
Plan IV	131.6
Plan V	57.2
Total reported by plan	1,754.2
Other arrangements	141.0
Total terminations	1,895.2

for 72 percent of piggyback waybills. Illinois, New York, and New Jersey ranked high, with a large share of the traffic moving between Illinois and the latter two states.[31]

A measure of the relationship between containers and all piggyback loadings for the domestic movements in 1968 is shown in Table 11 below, which was compiled from individual carrier reports to the ICC.[32]

Table 11. Piggyback units and containers moved by all modes, 1968

Mode	Total Piggyback Units	Containers Units	Containers % of Total
Rail	1,915,200	154,600	8
Motor	308,000	63,200	21
Forwarder	242,800	10,000	4
Water	50,900	40,500	80
Totals	2,516,900	268,300	10.6

According to Table 11, approximately 10 percent of all piggyback movements are now being handled in containers. The same relationship applies if discussion is limited to motor and rail modes.

Marine Containerization

Although the primary area of concern in this paper is containerization in domestic freight shipments, the development of containerization in marine traffic deserves treatment because of its important influence in domestic activity. Those responsible for development of the practice in overseas shipments have provided leadership in improvements to "the box" and dockside handling equipment, and have created the "demand push" to move containers to inland destinations.

As in the case with domestic activity, containerized marine shipments had early origins. In the late 1800's "lift vans" were used in Germany, but they did not make an appearance in the United States until the 1890's because the hatches on the ships used then were too small to accommodate the large boxes. In order to avoid a duty on foreign-built lift vans, the Bowling Green Storage and Van Company was organized and began movement of household goods in American-built vans across the Atlantic in 1901. (The company is still in operation.) The Anglo-American Lift Van Co. was organized in 1911 for shipment of household goods to and from Europe. They had constructed fifty steel vans, each about 16 feet by 8 feet square, which could be fastened to flat bed trucks and were capable of handling the furniture in a six room apartment.[33]

Credit for the first major international use of containers goes to the United States Army. During World War II the Army turned to industry for solution to the problem of maximizing usage of available shipping space. A reusable container for shipping aircraft engines was developed and its use was later extended to other items. From this beginning the concept of the CONEX container, previously described, was developed. The Armed Services have now had over 20 years of experience with CONEX. By 1965, the fleet had grown to 100,000. In 1968, under the logistics pressures of the Vietnam war, the inventory of CONEX containers was expanded and stabilized at 200,000 units, which is the largest container fleet in the world.[34] The inventory is now in the process of being modified to include 20 and 40 foot standardized van containers.

Credit for initiation of present-day commercial marine container movement is generally credited to Malcolm McLean, at that time head of a trucking company, who recognized the potential for reduction of repetitive handling of freight in intermodal transfers. McLean purchased the Pan-Atlantic Steamship Company as the nucleus for Sea Land Company, which he founded in 1955. The ships were converted for container service, which was offered on intercoastal routes between the east and west coasts of the United States and to Puerto Rico. Success of the undertaking in filling a demand is indicated by present estimates that over 90 percent of the marine traffic to Puerto Rico moves in containers. Sea-Land adopted a "non-standardized" 35 foot container on the basis of highway trailer dimensions which were in use at that time. Today the company controls a fleet of more than 30,000 containers and an ocean-going fleet of 46 trailer-ships which provide regularly scheduled calls at 36 terminals throughout the world.[35]

Matson Lines developed traffic with Hawaii based upon a 24 foot long container which could be hauled in tandem on West Coast highways. Grace Lines developed routes between the East Coast, West Coast, and South American ports using a 17 foot box initially and then switching to the standard 20 foot container. These lines were soon followed by United States and foreign firms in the development of Atlantic and Pacific containerized trade routes. An idea of the extent of growth is offered in the statistics presented below which were compiled by the Maritime Administration for the year 1968.

<u>U.S. North Atlantic/Europe Trade Route</u>:[36]

Twenty-eight percent of total commercial liner traffic moved in containers.

Cargo movement was carried in a total of 201,000 20-foot container equivalents.

U.S. flag ships carried 47 percent of the containerized commercial cargo.

U.S. Pacific/Far East Route:

About 6 percent of the total commercial liner cargo moved in containers.

The equivalent of 78,000 20-foot containers were used to carry the containerized cargo.

U.S. flag ships carried 49 percent of the commercial container traffic.

Third-quarter volume of containerized freight on the North Atlantic route increased from 479,000 long tons in 1968 to 824,000 long tons in 1969. Traffic on the United States/Far East route likewise increased from 159,000 to 518,000 long tons for the same periods.[37]

A 1969 listing by the Maritime Administration indicated that there were 79 United States flag containerships in service and another 103 ships with partial capacities for containers. At the same time there were under construction or on order a total of 122 containerships and 112 ships with partial capacities for containers. Twenty-three of the former group and seven of the latter group were being constructed in the United States.[38] It was estimated that there were about 79,000 containers in service on the oceans in 1967, and this number has had to increase considerably since then in order to take care of the dynamic growth in their use.

Air Cargo Containerization

A few comments are presented here on containerization of air cargo, primarily to round out the picture. The containers moved by air are subject to surface movement on short hauls to and from the airport. It is only within the past couple of years that aircraft capable of handling containers with an 8 foot by 8 foot cross section have been flying. Thus, the practice has been limited to use of a special line of containers designed to match the eliptical contours of plane cross-sections. These have been standardized under agreements reached by the International Air Transport Association (IATA) and have external volumes ranging up to about 425 cubic feet. A program for bulk unitization was introduced in October, 1969, whose purpose was to encourage shippers to offer to the IATA member carriers larger unit loads which would be packaged ready for transport. Reduced freight charges were offered in return for the expected reduction in ground handling costs and faster equipment turn-around.[39]

It is not likely that aircraft will haul the present standard 8 foot by 8 foot by 40 foot containers because they are too heavy. A minimum target by aircraft manufacturers of a weight to cube ratio is 1½ pounds to one cubic foot volume for containers, whereas the lightest weight containers that will stand up under surface use today run about a 4½ to one ratio. Some progress has been made through the use of magnesium and honeycomb wall construction. World production of aircargo van size containers was reported at 80 units in 1967 and was expected to climb to 1,480 units in 1969.[40] It may be surmised that such units would find initial use by the military on the giant C5A air cargo transport plane.

The critical need to conserve on tare weight has led to the development of unitized loads for aircraft based upon "igloo" shaped packages stabilized with nets or shrink film. These are used interchangeably with containers of similar shape, also called "igloos" and meeting IATA standards.

Rapid transfer of baggage at terminals is important to passenger convenience. This problem has been magnified with the advent of the new generation of planes, such as the Boeing 747, which are capable of discharging as many as 400 passengers at one time. Specially designed containers have been provided for use in these planes in order to handle miscellaneous baggage as unit loads, but they are not used intermodally.

Growth Projections for Containerization

Projections of the growth of containerization in the various modes have been made almost since the innovation was first practiced. It is a favorite subject for presentation at professional meetings. Numbers presented may be based upon careful analysis of existing trends, examination of potentials based upon the goods being handled in a given trade channel, or may merely be a reflection of enthusiasm on the part of the particular author. This section will treat briefly on some of the projections which are available in the literature.

Piggyback Projections

Rosey projections for piggyback growth were presented in an article in Railway Age in August, 1963, as follows:

> The trailer/container manufacturers have some intriguing predictions to egg them on: Their market researchers agree with TOFC experts who are estimating that railroads will carry 10 million trailer/container loads annually by 1970. . . . The highway hardware men can see where TOFC may be accounting for as much as 35% to 45% of all trailer and container production by 1970; production in 1962 was slightly in excess of 72,000 trailers.
>
> Predictions [as to how fast TOFC will grow] range from a low of a 15% increase compounded annually to a high of a 30% increase also compounded annually. Sticking to a rather conservative 20% annual increase, new trailer/container requirements involved in piggyback operations could amount to 118,000 units--even assuming that none of the trailers or containers in the existing fleet would need replacing in that period.[41]

The purpose of presenting a projection made in 1963 is to illustrate how far off the experts can be and to generate caution in accepting projections made today. It was noted previously in Table 11 that the total piggyback units and containers moved by all modes in 1968 was only 2.5 million and there was essentially no further growth in the practice in 1969. In the period 1963-1968 piggyback carloadings actually grew at about a 12 percent compounded annual rate. Trailer production for all uses was estimated by the president of Fruehauf, the nation's largest trailer builder,[42] at about 150,000 in 1969 and projected at only 100,000 for 1970 because of an economic downturn.

A more recent forecast, which also appears to be optimistic, was made in 1967 by Railway Age after a survey of major TOFC/COFC operators. For clarity it is presented in tabular form below, compared with 1966 figures.[43]

Table 12. TOFC/COFC--1966 actual vs. 1972 projection

	1966	1972
Piggyback carloads, millions	1.1	2.6
Trailers handled, millions	1.9	4.6
Piggyback revenues, $ millions	478	1,100
Piggyback car fleet, units	28,000	56,000
Trailer and container fleet, units	100,900	250,000

The same article quoted the general manager of Container Marine Lines, a division of American Export Isbrandtsen, that in the long run the Container-On-Flatcar (COFC) system would prevail, primarily because it requires less investment.

The forecast of the size of the piggyback car fleet in 1972 was not too far off, since Trailer Train Company, the major supplier, reported over 29,000 of its piggyback cars in service as of early in 1970.[44] Of the 100,900 unit trailer and container fleet referred to in Table 12, only about 16,000 were containers (20 foot equivalents) and this number had increased only to about 20,000 at the beginning of 1968. A report by Pullman-Standard quoted a rule-of-thumb that for every ten containers built for maritime service, approximately one is built for purely domestic use.

Kaiser Aluminum Company recently made a more conservative estimate of the piggyback van trailer and container fleet at 198,700 units by 1977.[45] The estimate also included the following production schedule for that year:

Piggyback van trailers and containers	31,900 units
Highway van trailers	88,100 units
Total	120,000 units

A survey among piggyback managers of the major railroads at the end of 1969 developed the conclusion that piggyback operations are expected to continue to expand in numbers of carloadings, trailers and containers handled, and in the share of total freight revenues. Profitability will be enhanced by taking a more selective look at the type of traffic the railroads will handle; unprofitable short hauls will be pruned. Better service will be provided through the use of all piggyback trains. The trend is already accelerating, with announcements by Missouri Pacific, Penn Central,

and Southern Railroad of such schedules. Experiments with the present rate plan structure are forecast in an effort to make piggyback more attractive to the shipper. Optimism prevails and the current slowdown in growth is attributed to the downturn in the economy, combined with an extended nationwide truck strike in 1970.

Projections of Total Container Usage

The discussion has centered on containers for piggyback service since this relates to domestic surface freight shipments. However, to develop a picture of total container growth projections, it should be pointed out that the piggyback segment amounts to only about 14 percent of the container inventory. The relationship is borne out in Table 13, which follows.[46]

Table 13. United States container inventory (number of 20 foot equivalents as of January, 1968)

Owner	No.	%
Marine	100,840	70
Leasing and forwarding	23,840	16
Rail	19,950	14
Truck	170	--
Total	144,800	100

The Commercial Research Division of United States Steel Co. recently developed a container annual demand schedule over the period 1969-1977 which was based upon an estimated range maximum inventory of 640,000 units and a minimum of 320,000 units by 1977.[47] The big spread in the projection was justified upon the numerous uncertainties facing full acceptance of their use--the central concern of this research. Their estimates of annual demand for 20 foot equivalent units were:

Year 1969	25,000 to 38,000 units
Year 1977	45,000 to 88,000 units.

The general concensus of most surveys is that there will be 300,000 to 400,000 containers in service by 1975. The major source of demand will continue to be for marine service. Litton Systems published a study of oceanborne shipping demand for the years 1973 and 1983 under a contract with the Department of Transportation.[48] The forecasts were developed by analyzing characteristics of 34 trade routes in terms of growth characteristics and percentages of containerizable cargo carried. Their overall summarized conclusions are presented in Table 14.

The important point about the projections is that break bulk cargo is expected to decline in favor of containerized movements, in spite of an overall growth in trade. Pertinent to the investigations of this paper are the projections of the amount of liner trade which will move in unit trains in the domestic portion of the journey.

Table 14. Projected containerization of United States liner cargos

	1973		1983	
	Tons	%	Tons	%
Containerized	12,320,700	23	25,605,600	41.5
Break bulk	41,117,300	77	36,143,400	58.5
Total	54,438,000		61,749,000	

These are summarized in Table 15, and are based upon the assumption that essentially all of the "prime" containerizable items will be so handled in 1973 and the "suitable" containerizable items will be added by 1983.[49]

Table 15. Projected liner trade moving on unit trains

Year	Total Trade (thousand long tons)	Unit Train Volume (thousand long tons)	%
Exports:			
1973	8,955	1,659	18.5
1983	11,876	5,646	47.5
Imports:			
1973	4,531	1,380	30.0
1983	5,811	2,924	50.0

Expansion of unit train operations is expected to cause a decline in the Great Lakes overseas trade and produce some reallocations between the Gulf, Atlantic, and Pacific Coast ports. In any event, such developments are sure to act as a catalyst to further growth of domestic surface freight containerization. Increased demand for service will justify investment in facilities which can be used to expedite goods consigned to both foreign and domestic destinations.

Little has been said about the role of the highway carriers in projected growth of containerization. Figures in Table 13 indicate that truckers owned only about 0.1 percent of the United States container inventory in 1968. However, few international movements of containers are completed without the service of truck lines, whether for line-haul or pick up and delivery service. Truckers are largely disinterested in containerization, for reasons more fully developed later in this investigation. However, as truckers gain experience in the practice they can be expected to become party to intermodal transfer agreements which may prove economically advantageous to themselves as well as to the shippers.

Containerization of air shipments can be expected to expand at the highest growth rate among the modes over the next few years, first because of its present small base, and secondly, because it expedites ground handling, thus allowing more active use of very expensive planes.

Containers and Handling Equipment

This literature review is aimed at developing a background of understanding of the practice of containerization of goods for freight shipments. This section is intended to provide a description of the tools of the practice, namely, the containers themselves and the specialized equipment used to handle them. A review of developments in this field indicates two opposing forces at work: (1) efforts to standardize containers and equipment in order to simplify and minimize costs of intermodal and intramodal transfers and (2) continuous innovation and modification of the hardware to meet specialized needs and to improve projected investment returns. It appears that continued growth in the use of containers will require the needs to be served in both areas, hopefully with a reconciliation of opposing aims.

A large number of containers in service today meet the requirements of the International Organization for Standardization (IOS). The work of this organization and standards in general will be discussed more fully in Chapter III. However, the dimensions for the two groups of containers included in the standards are presented here now, since much of the discussion in this section relates to them.

Series I has an 8 by 8 foot cross section as follows:[50]

Nominal Size (feet)	Volume (cu. feet)
40 x 8 x 8	2560
30 x 8 x 8	1916
20 x 8 x 8	1272
10 x 8 x 8	628
6-2/3 x 8 x 8	413
5 x 8 x 8	320

Series II has a uniform nominal height of 6 foot, 11 inches and the three containers have the following nominal dimensions:

Height	Width	Length
6 ft., 11 in.	7 ft., 7 in.	9 ft., 7 in.
6 ft., 11 in.	6 ft., 11 in.	7 ft., 11 in.
6 ft., 11 in.	7 ft., 7 in.	4 ft., 9 in.

Standard terminology has been developed. Of particular interest is the standard definition of a freight container, as follows:

> By freight container is meant an article of transport equipment
> (a) of a permanent character and accordingly strong enough to be suitable for repeated use;
> (b) specially designed to facilitate the carriage of goods by one or more modes of transport, without intermediate reloading;
> (c) fitted with devices permitting its ready handling, particularly its transfer from one mode of transport to another;
> (d) so designed to be easy to fill and empty;
> (e) having an internal volume of 35.3 cu. ft. (1 cu. meter) or more.
>
> The term freight container does not include vehicles or conventional packing.[51]

The American Bureau of Shipping has a similar definition for a cargo container, but sets a minimum volume of 628 cu. ft.

The Bureau tests, inspects and certifies containers meeting its requirements.

Types of Containers in Service

Containers in actual service vary as to dimensions, materials of construction, and in special features, according to the needs of the users. Steel is the basic building material, especially where strength is required and where weight is not of prime importance, as in marine service. However, an area of continuing development involves the use of material combinations designed to reduce tare weight without sacrificing serviceability. Major materials include plywood, aluminum, magnesium, honeycomb panel constructions, and fiberglass reinforced plastic panels.

A recent port activity survey by the United States Maritime Administration developed the following analysis of container lengths in use, while the Truck Trailer Manufacturers Association published the distribution of container lengths produced in 1968, as listed in Table 16.[52]

Usage was surveyed in North Atlantic Ports; had the Pacific Coast been used, 24 foot containers (used by Matson) would more closely have balanced production. The 35 foot output is presumably to meet demand from Sea Land. The bulk of production is in the standard 20 and 40 foot lengths, with the latter growing in importance, especially for domestic traffic.

Table 16. Container length--usage and 1968 production

Selected Area Usage		Production	
Length (feet)	Proportion (%)	Length (feet)	Proportion (%)
10	1.96	10	0.48
20	55.93	20	37.45
30	0.13	24	9.25
35	15.25	35	25.50
40	25.58	40	27.30
Other	1.15	Other	0.02
Total	100.00	Total	100.00

In addition to the general dry cargo freight container the following are among those available for special services:

1. Open top general cargo to permit overhead loadings and discharge.
2. Refrigerated cargo or "Reefers" to transport meats and other perishables.
3. Controlled temperature cargo which is heavily insulated for transport of perishables and delicate equipment.
4. Heated cargo for use in cold climates, such as Canada, to prevent freezing of such commodities as beer.
5. Tanks to transport whiskey, liquid foodstuffs and chemicals.
6. Cattle carriers to transport live animals.

7. Open tray bulk, similar to general cargo but less than 8 feet high for high density materials.

The Flexi-Van fleet of the Penn Central comprises a special group of containers; the company has over 5,000 of them in service, as well as over 1,500 special flatcars.[53] The Flexi-Van differs from other containers in that it has all the features of a trailer (except wheels); it is equipped with a fifth wheel plate and kingpin, folding prop legs, and wiring. Of the twenty-two railroads with container handling facilities, four have Flexi-Van facilities only. The Penn Central has found that while an ordinary boxcar spends 43 percent of its life empty, Flexi-Vans are idle only 8 percent of the time.

Container Handling Equipment

Because of their large size and weight when loaded, containers require specially designed equipment for handling. The containers must be loaded and unloaded from flatcars, from over the road chasis, into holds of containerships, and stored at shipping docks or stacked in multiple height tiers. Handling equipment includes regular cranes, gantry cranes, straddle cranes, and special fork lift trucks. Capacities of railroad owned equipment vary up to fifty tons lifting ability, with a large share of the equipment capable of handling at least forty tons. Where a rail line does not have handling equipment at a destination terminal, the

container is shipped on a chassis/bogie assembly and unloaded from a ramp. A special system which is particularly popular in Canada is the Steadman side-transfer unit. It involves the use of a semi-trailer equipped to move a container on or off a flatcar in a sideway movement. The importance of handling equipment to a containerized operation is demonstrated by the experience of the Southern Railroad. They attribute part of their success to their ability to design and build handling cranes at a cost which allows them an acceptable return on their investment.

Special flatcars are needed to carry containers over the rails. In 1955 a group of railroads created the Trailer Train Company with the basic purpose of providing standardized piggyback cars to the industry.[54] The original fleet consisted of five hundred 75-foot roller bearing flatcars equipped with standardized trailer locking devices. Since then additional models have been developed to handle longer and heavier loads. The "All-Purpose" car will handle containers and trailers interchangeably and is over 89 feet long (thus two 40-foot containers can be carried on the one car). Rental rates are based upon a combination per diem and mileage charge, with the schedule designed to promote high active use of the cars.

Pallets and Unitized Loads

A brief review of the literature on pallets and unitized loads is included because this shipping alternative can affect the growth of containerization by offering some of its advantages at lower investment cost. In this review the definition of the Unit Load Council is used:

> A unit load is one or more packages secured to a pallet, skidded or strapped together in such a manner that the entire unit may be handled efficiently from the manufacturer's plant, received by the ocean carrier, safely loaded, stowed under deck in the vessel and quickly delivered at the port of discharge by mechanical equipment.[55]

The Unit Load Council, comprising a group of ship-lines, has been formed to develop and promote the unit-load concept in international trade. However, the practice finds wide application in domestic surface and inland waterway movements as well as in air traffic. In fact, unit-loading methods are used in a high proportion of air cargo traffic.

Many of the advantages claimed for containerization are also available in unitized loads. Included are reduction in handling time and costs, less damage to goods, door-to-door movement of consignments, simplification of billing procedures, and increased customer satisfaction. Because the unitized lots are normally much smaller than containers they do not require the use of sophisticated, expensive handling equipment. The loads can be placed aboard boxcars, ordinary flatcars, or in over-the-road highway trailers using common fork lift trucks. Offsetting this latter

advantage, when compared with containers, is the greater time required for transfers at the intermodal interface.

Pallets are the most common and one of the most efficient means of unitizing loads. Complete pallet loads can be stacked in consolidated tiers during shipping or storage without the need of racks, thus maximizing utilization of cubic space. Since they are used universally, deadhead returns of empty pallets to equalize unbalanced traffic is not a major problem. They can be constructed cheaply enough so as to be expendible if dead heading is a problem. The sizes most frequently used are 40 by 48 inch and 32 by 48 inch. The Department of Defense has established military standard palletized loads based upon the 40 by 48 inch pallets, skids, runners, or pallet-type bases.[56] Standardized arrangements have been developed for positioning unit goods on pallets in order to stabilize the load and minimize void spaces.

The most recent development which is likely to influence the growth rate of containerization is the advent of shrink wrapping of pallet loads. It has been estimated that by 1975 some 1,000 package-using companies will have pallet-load shrink-wrap systems, as compared to about 80 using them in 1970. In 1968, eighteen million pounds of polyethylene film was used for shrink wrapping, and this is projected to grow to 200 million pounds by 1975.[57] A large share will be used on pallets.

A hand unit which allows one to shrink wrap a pallet in eight minutes can be purchased for less than $500. A typical average machine now sells for about $20,000, while a highly automated high capacity installation may cost up to $140,000. The point is that small operators can adopt the innovation with a minimum investment, and some goods that might otherwise be containerized can be handled on shrink pallets instead. Items which have been so wrapped include refractory bricks, cement sacks, cartoned goods, and five gallon paint can loads.

Economies of shrink film wrapping have been suggested in five areas: (1) lower cost packaging materials may be acceptable, (2) automated equipment can reduce labor cost, (3) pallet overwrapping does not require highly skilled labor, (4) the lightweight plastic film helps reduce freight charges, and (5) inventory costs of packaging materials is reduced.[58] Savings of $0.50 to $2.40 per pallet load over conventional palletizing methods have been reported.

It can be expected that shrink-wrapped pallet loads will also be moved in containers. Reduced costs in transferring unitized loads in the containers at both ends of the trip can be realized. Elimination of damage by abrasion during shipping is a possible benefit. Unitization of odd-shaped items can aid in reducing stuffing time and in improving stability of the container load. The advantages of containerization and unitization of loads can be cumulative

but the ultimate growth patterns will be determined by relative benefits and customer satisfaction.

Conclusions to Containerization Background

The literature review presented thus far has been intended to bring out the role that containers fill in expediting intermodal transfers. The background material includes the historical development of intermodalism, the benefits derived from the practice, and some of the factors which have had to be dealt with in order to arrive at the present state of the art.

The next section reviews those offerings in the literature which shed light on factors which are assumed to be inhibiting growth of containerization in domestic freight shipments. The background presented thus far should be helpful in orienting the reader to a better understanding of the problems.

CHAPTER II--FOOTNOTES

[1]Patrick Finaly, ed., Jane's Freight Containers (New York: McGraw-Hill Book Co., 1969), Foreword.

[2]Morris Forgash, "Containerization--A Tool of Transportation," in Transportation Century, ed. by George F. Mott (Baton Rouge, Louisiana: Louisiana State University Press, 1966), p. 194.

[3]John F. Magee, Industrial Logistics (New York: McGraw-Hill Book Co., 1968), p. 135.

[4]Charles A. Taff, Management of Traffic and Physical Distribution (Homewood, Illinois: Richard D. Irwin, 1964) p. 85.

[5]Richard T. Nagle, "Roll On-Roll Off: Piggyback Goes to Sea," Railway Age, October 27, 1969, pp. 46-47.

[6]"Ton Mile Distribution Among Intercity Freight Carriers," Distribution Manager, April, 1969, p. 24.

[7]James M. Dixon, "Trucker's Outlook Is a 'Mixed Bag'," Distribution Worldwide, April, 1970, p. 37.

[8]U.S. Department of Commerce, Office of Business Economics, 1969 Business Statistics (Washington, D.C.: Government Printing Office, 1970), p. 119. Reported tons are estimated as ton-miles for foreign shipments.

[9]Thomas F. Dillon, "Containerization--A New Twist on an Old Idea," Purchasing, January 28, 1962, p. 84.

[10]Maritime Cargo Transportation Conference, Inland and Maritime Transportation of Unitized Cargo (Washington, D.C.: National Academy of Science, 1963), pp. 33-36.

[11]R. E. Colton and E. S. Ward, Practical Handbook of Industrial Traffic Management (Washington, D.C.: The Traffic Service Corp., 1965), p. 149.

[12]Joel Nelson, "Pilferers, Hijackers Confound All Parties," Metalworking News, May 4, 1970, p. 20.

[13]Eugene R. Birchler, "Six Myths About Containerization" (paper presented before International Executives Assn., Statler Hilton Hotel, New York, N.Y., February 18, 1969), p. 2.

[14]Maritime Cargo Transportation Conference, p. 36.

[15]B. J. Hale, "Containerization--A Vital Part of the Mattel Success Story" (speech before the Fifth International Container Services Exposition, Chicago, Illinois, April, 1970), p. 2.

[16]R. H. Autenreith (statement before the Containerization Institute Conference, Los Angeles, California, November 13, 1969).

[17]Gen. Frank S. Besson, Jr., "Defense Implications of Containerization" (talk before the Fifth International Container Services Exposition, Chicago, Illinois, April, 1970).

[18]"Consulting Engineer Believes Containers Will Replace Trailers in Piggyback Service," Traffic World, October 31, 1959, pp. 42-43.

[19]"Containerization's Changing Patterns," Fleet Owner, January, 1961, p. 67.

[20]An Economic Study of Containerization and Its Markets (Richmond, Virginia: Market Research Dept., Reynolds Metals Co., 1961), p. 4.

[21]U.S. Interstate Commerce Commission, 293 ICC 93, July 30, 1954, ICC Docket No. 31375, Movement of Highway Trailers by Rail, ICC Reports Vol. 293, June, 1954-January, 1955 (Washington, D.C.: Government Printing Office, 1955), p. 94.

[22]U.S. Interstate Commerce Commission, 173 ICC 377, April 14, 1931, ICC Docket No. 21723, In the Matter of Container Service, ICC Reports Vol. 173, March-April, 1931 (Washington, D.C.: Government Printing Office, 1931), p. 384.

[23]Ibid., p. 386.

[24]293 ICC 93, ICC Docket No. 31375, p. 95.

[25]U.S. Congress, Senate, National Transportation Policy, John P. Doyle, Staff Director, Report No. 445, 87th Congress, 1st Session, June 26, 1961, p. 654.

[26]Ibid., p. 655.

[27]Josephine Ayre, "History and Regulation of Trailer-On-Flatcar Movement," in Highway Research Record, No. 153-Piggyback (Washington, D.C.: National Academy of Science, 1967), p. 5.

[28]Ibid., p. 6.

[29]Yearbook of Railroad Facts (Washington, D.C.: Assn. of American Railroads, 1968), p. 33; and Burton N. Behling, "1969 Review," Railway Age, January 19, 1970, p. 59.

[30]U.S. Interstate Commerce Commission, Bureau of Economics, Transport Economics (Washington, D.C.: Government Printing Office, July, 1969), p. 2.

[31]U.S. Interstate Commerce Commission, Bureau of Economics, Piggyback Traffic Characteristics, Statement No. 66-1 (Washington, D.C.: Government Printing Office, December, 1966), pp. 1-3.

[32]Transport Economics, April, 1970, p. 12.

[33]"Trans-Atlantic Containerization--Circa 1901," Distribution Age, February, 1967, p. 36.

[34]Gen. Frank S. Besson, Jr., p. 8.

[35]Commercial brochure published by Sea-Land Co., New York, New York.

[36]U.S. Department of Commerce, Maritime Administration, Foreign Oceanborne Trade of the United States--Containerized Cargo (Washington, D.C.: Government Printing Office, September, 1969), pp. 2-6.

[37]Ibid., pp. 4-7.

[38]U.S. Department of Commerce, Maritime Administration, U.S. Flag Containerships and U.S. Flag Ships with Partial Capacities for Containers (Washington, D.C.: Government Printing Office, 1969).

[39]IATA Bulk Unitization Concept (Montreal, Quebec: International Air Transport Assn., 1969), p. 2.

[40]Containerization, An Outlook to 1977 (Oakland, California: Kaiser Aluminum and Chemical Co., 1968), p. 31.

[41]"For Trailer/Container Builders: Market Boom in TOFC," Railway Age, August 26, 1963, pp. 19-20.

[42]"Fruehauf Sees 33% Fall in Trailer Industry's Volume During 1970," Wall Street Journal, August 31, 1970, p. 15:3.

[43]Gus Welty, "TOFC/COFC: Why the Future Looks So Good," Railway Age, May 29, 1967, p. 33.

[44]Annual Report, 1969 (Philadelphia, Pennsylvania: Trailer Train Co., 1970).

[45]Kaiser Aluminum and Chemical Co., p. 1.

[46]Containerization--A Maturing Intermodal Transportation Concept (Pittsburgh, Pennsylvania: Commercial Research Div., United States Steel Co., August, 1969), pp. 20-25.

[47]Ibid., pp. 5-6.

[48]Litton Systems, Inc., Oceanborne Shipping: Demand and Technology Forecast--Part 2 (Washington, D.C.: Government Printing Office, 1968).

[49]Ibid., pp. 6-25.

[50]Jane's Freight Containers, p. 487.

[51]Ibid., p. 490.

[52]United States Steel, p. 29.

[53]R. G. Hilts, ed., The Official Intermodal Equipment Register (New York: Intermodal Publishing Co., August 25, 1969), p. 70.

[54]Trailer Train Co., pp. 1-4.

[55]"Unit Load Council Set," Distribution Worldwide, May, 1970, p. 26.

[56]See Military Standard Palletized and Containerized Unit Loads, MIL-STD-147B (Washington, D.C.: Department of Defense, April 30, 1968).

[57]"Shrink-Wrapping of Pallet Loads to Grow," Package Engineering, May, 1970, p. 32.

[58]"Shrink Film Palletizing: It's Everybody's Baby, Now," Material Handling Engineering, February, 1970, p. 73.

CHAPTER III

REVIEW OF LITERATURE--II

Factors Affecting Containerization Growth

Current literature provides a rich source of opinion and facts relating to factors influencing growth of domestic containerization. Economic considerations can be identified as the basis for most matters appraised, whether they be government regulation or standardization of equipment. This literature review first examines the primary factors of cost, investment, and income determining rate structures which are normally considered to influence profitability of physical distribution activities. The areas of equipment standardization, equipment availability, government influence, and labor which bear on the problem of containerization development are then reviewed.

Factors discussed in the literature have been used to develop the research questionnaire presented in Appendix A. The questionnaire has been used to establish the relative importance of the various factors believed to be impeding growth of domestic containerization, as viewed by those engaged in physical distribution activities.

Major Economic Factors: Operating Costs, Investments, and Rates

Comparative Operating Costs

Comparative operating costs generated by break-bulk versus van trailer and/or container consolidated movements are of importance to the carrier in determining service to be offered. An innovation, such as containerization, is attractive if it offers a carrier the opportunity of increasing profit margins given current business, or helps to attract traffic from competing modes, or allows generation of new volume.

Table 17 (presented in three parts A, B, and C), taken from the literature, develops an analysis which shows the cost benefits of cargo unitization, both in the inland portions and in the overall costs of a marine export shipment.[1] Savings are much more dramatic in the total trip but are also evident in the inland segment. The analysis may mirror the basic reason for the explosive growth of containerization in marine shipments as compared to domestic activity. In the development of Table 17, inland line haul distances are assumed at 220 miles for truck and 370 miles for rail. Cargo of 29.5 lb. per cubic foot is assumed unitized at the shipper's premises.

The tables indicate about a 20 percent savings for the containerized shipment as compared to the break-bulk transfer. The palletized load is the least desirable in

Table 17-A. United States inland cost for 220-mile truck haul

	Unitizing	Other Handling	Line Haul	Container/ Pallet Ownership	Total
	(dollars per measurement ton)				
Break-bulk	--	1.20	2.53	--	3.73
Pallets	2.06	0.53	2.72	0.04	5.35
40 ft. vans	0.38	0.20	2.62	0.10	3.30
20 ft. vans	0.38	0.20	2.69	0.14	3.41

Table 17-B. United States inland cost for 370-mile rail haul

	Unitizing	Other Handling	Line Haul	Container/ Pallet Ownership	Total
	(dollars per measurement ton)				
Break-bulk	--	1.40	2.42	--	3.82
Pallets	2.06	1.22	2.60	0.04	5.92
40 ft vans	0.38	0.20	2.37	0.10	3.05
20 ft vans	0.38	0.20	2.39	0.14	3.11

Table 17-C. Shipper-to-consignee costs for export cargo (assumes two 220-mile inland truck hauls)

	U.S. Inland	Steve-doring	Other Pier-to-Pier	Overseas Inland	Total
	(dollars per measurement ton)				
Break-bulk	3.73	5.15	5.83	2.63	17.34
Pallets	5.35	1.33	3.66	2.50	12.84
40 ft. vans	3.30	0.94	3.80	2.53	10.57
20 ft. vans	3.41	0.94	3.94	2.63	10.92

this case because of the extra cost of preparing the pallets, cube lost by pallet volume, and no opportunity for rehandling savings. Of particular interest is the lower total cost for a container movement carried 370 miles by rail as compared to a 220 mile truck haul. The benefits of unitization become more pronounced in the analysis of the cost of the same shipment, from shipper to consignee, including two inland and a marine movement. This is shown in Table 17-C.[2]

The comparative costs for boxcar and TOFC shipments were developed in a study at the University of Pittsburgh.[3] Eight regional freight districts in the United States were analyzed for different load levels and different hauling distances. While total cost levels changed with different parameters, out-of-pocket costs were always higher for TOFC movements. As an example, for the New England Region, a load of 20 tons hauled a distance of 500 miles was estimated at the following out-of-pocket costs:

		Cents/100 lbs.	
Boxcar	Terminal	18.8	
	Line-haul	47.0	
	Total		65.8
TOFC	Terminal	19.9	
	Line-haul	47.4	
	Sub-Total	67.3	
	Truck terminal	6.5	
	Trailer rental	6.9	
	Total		80.7

Boxcar service includes the cost of movement from the shipper's siding, whereas the TOFC movements to and from the rail ramps are added to develop "equivalent" service out-of-pocket costs.

While not directly comparable, results of a study by the ICC covering out-of-pocket costs for eight transcontinental truck lines indicate line-haul numbers higher than those listed above for TOFC transfers. At an average cost of 0.13 cents per cwt.-mile, a 500 mile truck run would cost 65 cents per 100 pounds, as compared to 47.4 cents for TOFC.[4] However, with rail terminal costs eliminated, line-haul costs from the truck terminal appear to be about equal for both systems.

The numbers presented do not indicate that piggyback has grown because of savings provided the carriers in line-haul and terminal car handling costs. Although presented back in 1931 in a landmark ICC container rate case, the cost and revenue analyses submitted below comparing less-than-carload and container experience indicate freight claims, clerical and platform costs provide savings more than offsetting higher line-haul and terminal costs for containers.[5]

Because of container rental charges, the Lehigh Valley showed less net revenue for container traffic than for boxcar shipments. New York Central had contract rights to use containers without rental; the ICC stated that claimed savings would have been entirely eliminated if equal container charges had been assessed. After reviewing all

Table 18. Revenue and expense--boxcars vs. containers

	New York Central		Lehigh Valley	
	Boxcar	Container	Boxcar	Container
	(dollars)		(dollars)	
Gross revenue per ton	13.76	8.71	13.32	8.99
Expenses per ton	9.47	2.24	5.59	3.55
Net revenue per ton	4.29	6.47	7.73	5.44
Expense items as percent of total expenses	(percent)		(percent)	
Rental of containers	--	--	--	34.39
Freight claims	1.30	--	1.84	--
Clerical costs	26.77	1.85	21.39	1.75
Platform costs	24.47	--	28.10	--
Crane costs	--	4.27	--	--
Switching costs	19.55	31.89	13.85	16.43
Road haul costs	23.55	55.34	31.51	44.44
Car maintenance	4.36	6.65	3.31	2.99
Total selected expense	100.00	100.00	100.00	100.00

the data the Commission concluded that in many cases container rates were lower than carload rates, without justification, and ordered then existing container rates cancelled.[6]

Despite higher operating costs, piggyback has been profitable to the rail carriers. In 1966 the New York Central reported that containers represented less than 1 percent of its total operating equipment (Flexivan service), yet provided 9 percent of its revenue and 16 percent of its earnings. Evidently the carriers learned that improved service could justify higher rates. As stated by Roberts,

> The potential benefits of coordination are to some extent measurable in terms of two of its possible effects on the performance of the transportation system: the costs of providing the services required for a particular transport mission, and the quality of these outputs. . . .
> Both aspects of performance are reducible to cost terms since the qualitative attributes influence shippers' overall costs, either through direct monetary effects on production and distribution outlays or through the opportunity costs of different sales levels attributable to customer servicing standards.[7]

As an indication of the comparative quality of service (measured in terms of mean days of transit time) for the modes under consideration, Roberts offered the following as shown in Table 19.[8]

Table 19. Mean transit times and standard deviations for selected modal transfers

	Rail		Truck		TOFC	
Mileage Band	Mean Time	Std. Dev.	Mean Time	Std. Dev.	Mean Time	Std. Dev.
	(days)		(days)		(days)	
200-400	6.00	2.49	1.51	1.14	1.73	1.01
800-1,000	7.34	2.24	6.47	2.66	2.36	1.04
2,000-2,400	8.64	2.34	--	--	4.22	1.20

The numbers indicate that beyond 400 miles TOFC provides faster service, and in all cases it provides more reliable service (smaller standard deviation).

Thus far the discussion has centered primarily on cost differences relating to boxcar or over-the-road movements, as compared to piggyback traffic. The literature offers some information comparing costs of container on flatcar (COFC) and trailer on flatcar (TOFC) movements which are important to this study. Santa Fe reported on tests comparing a 31 Flexi-Van car train (2 containers per car) and a 29 car conventional TOFC train (2 trailers per car) over a 20 mile high-speed track. Speeds ranged from 35 mph to more than 80 mph. Conclusions from the test were that "the cost of hauling a ton of freight is lower in containers than in semi-trailers . . . that use of containers would at least mean a savings in fuel, locomotive maintenance, number of drive units and equipment investment." An all container train was expected to have the advantage in speed, fuel consumed, motive power requirements and dependability; these considerations were important in the development of Santa Fe's "Super C" high speed piggyback service between Los Angeles and Chicago.[9]

The penalties for hauling trailers with added weight from chasis, as compared to containers, higher center of gravity and higher wind resistance have been estimated at up to 30 percent extra in terms of motive power and fuel to pull a trailer train.[10] The higher center of gravity of trailers was said to limit speeds on curves, contributed to instability problems, and to damage claims resulting when subjected to above-normal acceleration and deceleration.

Deadweight from the trailer bogie and trailer hitch was estimated at 2½ tons per unit.

After studying rail transport costs in the United States and Europe, a consultant from McKinsey & Company, Inc. concluded,

> Railroads in the United States have a significant opportunity to use containerization to competitive advantage in developing traffic and holding their share-of-market over road transportation. To do this, they will have to develop inland container train services not necessarily based on coast-to-coast, land-bridge operation, but rather on modern container train services with dedicated equipment and efficient, low-cost road/rail terminal operations.
>
> It appears that the key to success of container transport systems lies in high utilization of capital resources and low-cost, rapid transfer between modes and at terminals. Where this is being obtained, development of container services is moving ahead quickly. But where the age-old inefficiencies and high costs of intermodal transfer are retained, development is stymied.[11]

The major emphasis of the literature review thus far has been primarily related to rail movements. However, there is considerable demand for motor carrier transfer of marine containers to and from dock areas. One major water carrier states that 40 percent of his overseas cargo originates less than 200 miles from port. Railroad COFC movement is only marginally economical on distances up to 300 miles. Highway carriers are not enthusiastic about handling marine containers because they do not compare favorably in dead weight and load capacity with standards of regular van trailers. These differences are presented in Table 20 following.[12]

Table 20. Marine containers vs. regular trucking equipment

	Conventional 40 Foot Semi-Trailer	40 Foot Container	Two 20 Foot Containers
Tare Weight:	(pounds)	(pounds)	(pounds)
Tractor	15,000	15,000	15,000
Trailer	10,125	--	--
Container(s)	--	5,630	7,270
Chasis		7,000	7,000
Total tare weight	25,125	27,630	29,260
Container increment	--	2,505	4,135
Cubic Capacity:	(cu.ft.)	(cu.ft.)	(cu.ft.)
Trailer or container	2,390	2,258	2,220
Container decrement	--	132	170

Efforts have been made to overcome the disadvantages of dead weight and unfavorable cube. There are couplable 20 foot containers which require less chassis support, but truckers claim the coupling operation is bothersome. Cost of boxes constructed of materials lighter than steel tend to be higher, but the added cost is not borne directly by the trucker.

In carrying high-density cargo, marine carriers may load containers beyond the limits allowed in over-the-road transfer. This results in a trade-off between added handling costs at dockside and greater load aboard ship. Partial unloading of containers can cause delays for truckers. Another problem relates to the fact that containers on chassis moved inland for unloading must be returned to the seaport. The containers are less efficient for hauling domestic commerce on the back-haul and the geographical distribution of regular equipment is thrown out of balance. On the favorable side, truckers' capital investment is reduced, since the steamship lines supply the containers and the trucker must supply only the tractive unit, chassis and bogies. Savings are also made in dockside deliveries where the container is turned over to be loaded aboard a single ship instead of making several stops at various piers to unload LCL deliveries.

Perhaps the greatest concern of truckers is that they may have more to lose than to gain by a domestic container revolution. More than $4.6 billion of their total revenues comes from hauls greater than 400 miles. If the unit train concept takes hold, railroads are sure to go after a greater share of this traffic, as they have done in rack car hauling of new automobiles.

Nothing has been said thus far with respect to cost considerations of containerization for the shipper and consignee. In their case, costs are generally of the nonrecurring type that are associated with acceptance of innovation, such as training of personnel in any special procedures which might be involved in handling containers. Actually, the shipper receives a container on chassis delivered by the trucker in the same manner as he receives

a van trailer. If the shipper's goods are of low density, the reduced cube may be bothersome and a source of cost, since additional movements will be required to accommodate the same volume transferred. If the shipper incorporates the container into his production line or warehousing system he is faced with possible handling equipment investments, but these are likely to be justified by reduced production handling costs. Shipping costs will be discussed later, but piggyback charges are the same for a van or a container delivered to the rail yard.

Investment Costs for Containerization

It has been estimated that transportation private capital expenditures in the United States traditionally average about 2 percent of the gross national product for equipment alone.[13] At present levels this amounts to near $20 billion annually. No more than 10 to 20 percent can be generated internally through depreciation and retained earnings, so the burden is carried by the investment community. Tight investment money and high interest rates restrict new project considerations to those with assured high returns and quick payout. These requirements are apparently being met in marine transport containerization, based upon the proliferation of containerships and containers to fill them. However, investment opportunities are not nearly so attractive for domestic containerization. For one thing, cost improvements are small when switching from trailers to

containers, as compared to switching from marine bulk to containerized freight. Secondly, a huge investment exists in piggyback trailer equipment; the National Railroad Trailer Pool operated by REALCO is currently about 20,000 units.[14]

The cost of a standard 20 foot container has been reported at about $1,500 in steel, $2,000 in aluminum, and $6,000 in plastic construction. Special containers, such as "reefers" (refrigerated boxes) cost up to $18,000 each. To the cost of the container must be added approximately $3,500 for a set of wheels. Thus, the combination cost is $5,000 to $5,500 for a 20 foot box, and $6,000 or more for a 40 foot container/chassis assembly. In comparison, a highway trailer costs about $4,500 and a rail boxcar sells for about $9,000.[15] Thus, a container/chassis rig is more expensive than a highway trailer by $1,500-$2,000, and the equivalent shipping volume (two containers) is more expensive than a boxcar. The unfavorable economics of shipping containers on wheels, as is the practice on most eastern railroads, is evident. On the other hand, for containers shipped without wheels, it is estimated that an average of one chassis is required for two containers where the movements are between major centers. This number approaches one-to-one as the system expands to include minor terminals. On a one chassis for two container basis, investment requirements are about equivalent to TOFC costs.

As was mentioned previously, the prospect of large operating savings in marine containerization justifies large equipment investments. It is estimated that two containers are required on shore for each container "on board" to assure rapid turnaround. Thus, for a ship designed for 1,000 containers, about 3,000 boxes would be included in the capital investment. The total cost for them would range from $6 million up to $17 million, depending upon their construction; this is comparable to the total cost of the vessel.[16]

Originally, loading and unloading of TOFC trailers was accomplished through the use of ramps in a "circus train" fashion. A tractor would back up a ramp, hook on to a trailer and haul it off. The process was repeated until the string of flatcars was empty and was reversed to reload the train. Because of the low investment, in the neighborhood of $10,000, the ramps proliferated. However, as volume at major centers increased the limitations of "circus train" loading became apparent and ramps are being replaced with mechanical loading equipment as quickly as volume justifies. It is estimated that it requires an average of 7 minutes per trailer to unload a normal piggyback train of 29 cars from a ramp. With modern cranes or side handling equipment, this can be done at an average time of 2 minutes per container. The difference in unloading time is thus about 5 hours when there are two trailers per flatcar. The extra time can make the difference in meeting connecting train schedules and in promised overnight delivery of trailers to customers.

A Steadman side-loading trailer, capable of transferring one 40 foot or two 20 foot containers from a flatcar is currently available at about $20,000. It has found acceptance in smaller yards and in captive use of large shippers who handle containers. Side-loading fork trucks large enough to handle containers range in cost from $120,000 to $180,000. Overhead cranes, depending upon capacity, range in price from $30,000 to $1 million, but the larger equipment is most likely justified at a marine terminal. Two traveling gantry cranes were installed at the Long Beach, California port to handle 20-ton containers at the rate of 60 per hour; cost was $1.3 million. A crane suitable for efficient handling of containers (or trailers) in a rail yard can be built for about $300,000. However, the possibility of interrupted customer service because of crane breakdown generates pressure from the marketing groups to provide backup equipment, even to the extent of duplicated facilities.

Flatcars provided with special fittings to tie-down trailers or containers are also expensive. A regular piggyback car offered for service by Trailer Train Co. costs about $16,500.[17] Newer "all-purpose" cars, which will handle combinations of 20 and 40 foot trailers and/or containers are estimated to cost near $20,000 each. This compares with a boxcar costing $9,000. However, one writer

claimed to show that investment costs in cars and containers were not overburdening when viewed as part of total operating cost. Using a 50,000 mile per year service (actually being obtained by Trailer Train leasees) the following numbers were presented:[18]

	(per mile)
Investment--flatcar	$0.016
Investment--containers	0.024
Transportation cost	
Flatcar	0.0825
Container & load	0.055
Maintenance--car	0.019
Total	$0.1965

A measurement of the investment requirements for piggyback distribution yards is indicated by a recent $3.5 million expenditure by Burlington Northern at its Seattle, Washington location. The installation included enough trackage to spot 100 flatcars, a 41-truck distribution center, a side-loading lift truck, and an 82 acre site.[19] With 1969 traffic at 22,000 piggyback units, the project was already scheduled for expansion. The facility highlights another investment requirement for piggyback operations: lots of land area for storage of trailers and containers. Here containers offer an advantage, since it is possible to stack them in storage and aisle space can be minimized where cranes and handling equipment are used for spotting them. Limitations of available space for piggyback distribution yards in urban areas are particularly pressing in the heavily populated Eastern states.

Conclusions Concerning Operating and Investment Costs

The key to success in container systems appears to lie in the high utilization of equipment made possible by rapid intermodal transfers at the terminals. Containers offer savings in long-distance rail line haul costs, when compared to trailers, because of their lower center of gravity, reduced wind resistance, and elimination of unused wheel assemblies. However, reductions in freight claims and clerical and platform costs are important sources of savings for both TOFC and COFC piggyback, when compared to break-bulk movements.

Offsetting the savings to carriers from piggyback operations are the increased investment costs. Handling equipment and terminal installations required to rapidly handle large numbers of containers are expensive. Combination container/chassis assemblies are more expensive than piggyback trailers, and the differential is aggrevated where additional bogeys are required to service a number of terminal locations.

The truckers are not anxious to work with containers. Added operating expenses are incurred because the cube of the containers and the handling requirements do not mesh with their van operations. Furthermore, they view expanded containerization as a threat to their share of the long-haul freight market.

The rate structures which have been developed to provide for profitable intermodal operations by the carriers are reviewed next.

Rate Considerations

Thus far the review of economic factors has been concerned with operating costs and investment requirements for containerization. These must be offset by income to the rail and highway carriers through rates established high enough to generate a profit, but low enough to attract traffic.

The regulatory authorities are constantly faced with the problem of reconciling the opposing rate requirements of the motor and rail modes because of their respective capital structures.[20] Fixed costs for railroads are large relative to total costs because the investment in equipment and facilities is large relative to output for a given period. Variable costs are small in comparison to fixed costs for the short run (five years or more). For the motor carriers, fixed costs are a very small portion of total costs. Variable costs for Class I common motor carriers of general freight have been estimated at more than 90 percent of total costs.

With a high variable cost factor it is not difficult for a motor carrier to determine his cost of service and use this as a basis for establishing rates. Without regulation the rail carriers can use their low variable costs to develop short term rates which can be ruinous for motor competition. The next section discusses the matter of regulated rates.

Intermodal Rate Consideration

In 1969 the ICC instituted a study of cost standards to be used in intermodal rate proceedings and invited comments on (1) what advantages of the modes are entitled to protection under the ICC Act, and (2) how should the costs of competing modes be recognized in order to preserve their inherent cost advantages.[21] As might be expected, the railroads urged that rates be based on long-run variable costs, while the motor and water carriers generally argued for a fully distributed cost standard. The variable cost base would allow the railroads to compete for traffic with lower rates. The Department of Transportation urged against the use of rate floors to protect one mode against the encroachment of another more efficient mode because the practice promotes inefficiency.

Intermodal service implies the use of more than one carrier, and the resultant need to divide revenues between them. In issuing rules requiring water carriers to file through, joint intermodal rates with the Commission, the FMC recently included the following definitions:

> Through Route: An arrangement for the continuous carriage of goods between points of origin and destination, either or both of which lie beyond port terminal areas.

Through Rate: A rate expressed as a single number representing the charge to the shipper by a carrier or carriers holding out to provide transportation over a through route.

Joint Rate: A through rate in which two or more carriers participate by agreement for the offering of through transportation over a through route published in the same tariff.[22]

The Federal Maritime Commission is limited to the port-to-port portion of joint rates. Jurisdictional squabbles have developed in the past when the Interstate Commerce Commission issued regulations pertaining to through rates which included marine transfers. The ICC has authority to prescribe through rates on rail-inland water routes. There is currently legislation under consideration in Congress which would extend ICC authority to prescribing through rates between motor carriers and for motor-rail intermodal movements.[23]

Although not required by the ICC, the motor and rail carriers do participate in joint rates, primarily under the piggyback Plan V. The plan provides for through routes under joint rates and effectively extends the territory of each participating carrier into that served by the others.

The advantages and disadvantages purported for the various piggyback plans are presented in Table 21.[24]

Most recently, the Missouri-Pacific offered a set of CONTAINERPAK plans for shipping by container.[25] The basic points of the program are as follows:

Table 21. Advantages and disadvantages of piggyback

Plan	Shipper	Motor Carrier	Railroad
Advantages:			
I	Service benefits of speed, dependability, safety of shipments	Economical to motor carrier; moves at motor carrier rates on a flat charge	Any traffic acquired adds to gross railroad revenue
II	(Same as Plan I)	Not available to motor carriers	Most desirable for railroad; all equipment used is operated by railroad on rail rates
II½	(Same as Plan III)	(Same as Plan III)	(Same as Plan III)
III	Provides more economical rates than other plans plus speed, flexibility, and safety of shipments	Not available to motor carriers	More revenue. Simplify terminal operations, increase flatcar use, allow better train schedules, lower capital needs, relieved of handling forwarder traffic
IV	(Same as Plan III)	(Same as Plan III)	(Same as Plan III)
V	Beneficial if available	Beneficial if coordination with railroads can be arranged	Beneficial if coordination with motor carriers can be arranged
Disadvantages:			
I	Higher cost than other plans	Additional $5 per trailer charge if piggyback used vs. road operation	Erratic volume. Motor carriers use for overflow traffic
II	No advantage; railroad owns and operates all equipment	Not available to motor carriers	Not profitable for short hauls because of terminal expense
II½	(Same as Plan III)	(Same as Plan III)	(Same as Plan III)
III	Must pay terminal charges and assume loss/damage claims. Limited to 60% rule	Not available to motor carriers	Use of long flatcars required to meet 2 for 1 rule
IV	(Same as Plan III)	Not available to motor carriers	Could interfere with rail interchange and car service problems
V	Limited application because through routes and joint rates not mandatory	Limited application	Limited application

Plan I: Door-to-door service on rail. Container remains on flatcar for loading/unloading.

Plan II: Door-to-door service on wheels. Container moves to/from flatcar and chassis.

Plan III: Covers all TOFC plans. Container moves on chassis at all times.

Plan X: Shipper-receiver innovation. Customer can develop plan tailored to his specific, special needs.

With the exception of modifications under the CONTAINERPAK program, containers and trailers enjoy the same rates as piggyback TOFC or COFC. Rate comparisons between modes are complicated by the tangle of rate structures, and normally comparisons can only be made for a given commodity. One example of such a comparison is given below as it was presented for testimony in an ICC hearing.[26]

Table 22. Rates by different transport methods (plastic materials--Philadelphia to Chicago)

Mode	Min. Weight (lbs.)	Rate ($/100 lbs.)
Rail boxcarload	70,000	0.85
Truckload	30,000	1.27
Plan II piggyback	30,000	1.27
Plan III piggyback	70,000[a]	0.85[b]

[a]Maximum for flat rate.

[b]Average.

The influence of tariff structures and commodity rates on cost of transport to the shipper is illustrated in Table 23. It compares boxcar and piggyback service, as quoted by a local freight agent for two different products shipped from Lansing, Michigan to New York City.

Table 23. Comparative transport commodity rates

Mode	Weight (lbs.)	Total Charge ($)
Motor Wheels:		
Rail boxcarload	72,000 min.	900.00
Plan II½ piggyback	72,000 max. for 2 trailers	565.06
Bricks:		
Rail boxcarload	70,000 min.	406.58
Plan II½ piggyback	72,000 max. for 2 trailers piggyback	565.05

To be equivalent to boxcar door-to-door service, approximately $60 should be added to the above piggyback numbers for delivery and pickup of the trailer from the rail yard. Another difference would be free return of pallets or other special crating (such as those used for motor wheels) if the load moved by boxcar, whereas there would be a dead head charge via piggyback service.

As a result of extensive investigations by the ICC over the period 1958-1965 it was generally concluded that the rates quoted by the railroads for Plans III and IV do allay out-of-pocket costs and contribute to fully distributed costs. Further, the railroads were able to retrieve some traffic from private carriage by offering these two plans.[27]

There is considerable argument that containerization and piggyback movement can be promoted through more universal application of freight-all-kinds (FAK) rate structures. The philosophy is that what is contained in the box being moved should be of no concern to the carrier, providing he is not required to assume extra liability or bear added costs for special handling (as with hazardous materials). The carriers are concerned that where the option of either commodity or FAK rates are available, the shippers will choose the cheaper of the two, depending upon the commodity being moved, and that the resultant rate loss will not be compensated for in additional traffic volume.

In reply to the question, "What are the specific steps that need to be taken in order that intermodal containerization can reach its full economic potential?", a trucking company official replied as follows:[28]

> The first thing that has to be done is to throw out the classification system. If you want a container . . . to represent movement of freight from door to door, then you have to throw out classification by rail, by truck, and by steamship. You then have a space problem and

> then both the on-land carriers and the ocean carriers would have to get together and decide that a 20 ft. container takes up so much transportation money and assess a charge against that container regardless of what is that's in there, limited only by the weight laws--the structural capacity of the container or highways.
>
> This condition exists in the United States today. We do have, in rail piggyback, a weight limitation, but they don't ask for the commodity [Plan III and Plan IV]. Morris Forgash convinced them that they should haul two trailers on a flat car at a flat price and it shouldn't make a bit of difference to them what the freight was. As a "sop" to the railroad classification situation they agreed that no one commodity would be in excess of 60 per cent of the lading in two containers, or two trailers [60 percent rule].

Perhaps a quotation by Owen is a suitable means for winding up this literature review on the economics of containerization and piggyback.[29] He stated,

> Even if we managed to get all the cost information needed to determine the total impact of the container movement on total distribution costs, we would still be faced with an equal problem of how to fairly distribute costs and savings among the shipper, carrier, and consignee. The one who incurs the cost may not be the one who achieves the most savings.

<u>Summary of Review of Economic Factors</u>

Efficient intermodal operations can result in benefits to both the shippers and carriers. Added investment costs borne by the carriers to support intermodal service must be reflected in the rate structures. However, improved service through greater speed and reliability justify the payment of increased charges by the shippers.

Governmental rate regulation is designed more to maintain a "status quo" situation, rather than to promote overall maximum efficiency in the freight transport system. Overlapping areas of responsibility and voids in coverage contribute to rate confusion.

The concept of FAK (Freight-All-Kinds) rates being applied to container cargos is compatible with intermodal transport thinking. Broader use of FAK rates for containers will further increase the efficiency of the system. Containerization may thus be expanded sufficiently to more than offset losses of revenues derived from high rates for classified commodities.

Equipment Availability: Leasing and Pooling

The practice of leasing can be used to shift financial requirements of an operation from investment to operating costs. Leasing can promote containerization by making equipment available as needed, but can deter the development if the rental rates are economically unattractive to potential leasees. The current literature has been reviewed in order to develop an understanding of current equipment leasing practices as they pertain to the development of containerization. Much of the material relates to leasing of equipment for marine transfers since this has been the greater area of need to meet demands of dynamic growth.

However, the information available generally pertains to leasing requirements for the domestic area as well.

Just about any piece of equipment needed for intermodal freight service can be obtained through leasing. For over-the-road movements, tractors, piggyback trailers, chassis, and an assortment of containers are available. For rail operations, various flatcars and equipment for handling containers and trailers are leased. In 1963 it was estimated that about 35 percent of the TOFC/COFC trailers and containers were leased.[30] Estimates have been made that up to 80 percent of the containers will be leased in the future. Presently, there are about 100,000 leased containers in service (more than half in use on the North Atlantic). The number of leased containers in international trade is expected to increase fourfold in the next five years.[31] Trailer Train has close to 30,000 piggyback flatcars under lease to member railroads. About 70 percent of the trailers in piggyback service are leased, rather than being owned, by the railroads. The National Railroad Trailer Pool operated by REALCO approaches 20,000 units; for the first time container/chassis combinations are being made available through their pools. Intermodal Transportation Systems (ITS) has begun to lease a specially designed "Intermodal Unit" container and chassis which can be used as a piggyback trailer or, without the wheels, as a marine container.[32]

There are two basic types of leases. The first, a financial lease is a long-term instrument, averaging about eight years, in which the payments over the full term are equal to the cost of the equipment, plus interest. Financial leases are usually offered by equipment manufacturers or financial institutions, such as banks, and are equivalent to a finance purchase plan. Financial leases are noncancellable, do not provide for maintenance or repairs, and the per diem costs run lower than they do for the second type, an operating lease.

There are many variations of the operating lease, which usually runs for one to three years. It may require the leasor or leasee to maintain and insure the equipment. It may include an option to buy or exchange the item, or to pick it up in one city and return it in another. Provisions may include return of a container to the owner at the end of the period or for continued use at reduced rates. In the case of trucks, for example, agreements may vary from a single trip lease to a full service contract over the depreciation life of the vehicle.

Leasing in general offers the advantages of minimizing capital tied up in equipment, tax deductions of the payments as operating costs, and protection against obsolescence of equipment. Container leasing offers certain special benefits. Interchangeability allows a firm to evaluate different materials of construction and types in service. Terms can be arranged to contract for a minimum

number, with provisions for expansion of the container fleet to take care of cyclical or peak demands. If the leasor has a sufficient number of containers in service, pool arrangements can be established whereby the boxes can be dropped off at a center at the end of a one-way trip, thus eliminating the cost of dead-head returns of empty containers. The leasor arranges for reuse of the box. Such provisions are offered by Container Transport International, Inc. (CTI), which has a fleet of over 30,000 containers and related equipment.[33] All sectors of the trade benefit when leasing and pool arrangements result in higher utilization of a given lot of containers in revenue service.

A pool should not be thought of as a collection of containers sitting in an open field, waiting to be used. This is a waste of valuable resources. A pool is a dynamic operating system with the following characteristics:[34]

1. Broad participation by a large number of users.
2. Universality of equipment, allowing for broad utility by a large variety of users in a large number of locations. Standard highway tractor-trailer assemblies meet this criterion. Nonstandard containers lack universality.
3. Accessibility of equipment at many locations; the availability of Trailer Train flatcars throughout the railroad system is an example of an accessible pool.

4. Availability of sufficient equipment to meet cyclical demands. This criterion is not met if all of the equipment is on specific assignment.
5. Control of equipment to assure high utilization experience. Computer programmed tracing and effective enforcement of rules, as well as means for redistribution of equipment are required control tools.
6. Equitable sharing of economic burden among the member-users, based upon equipment usage.

One writer believes that the economics of containerization will dictate a total interchange pool--international and intermodal--of compatible containers.[35] This would allow random interchange among modes, use of fairly standardized handling equipment, and rate structures adjusted to compensate for equipment imbalances. On the other hand, Missouri Pacific Intermodal, Inc., a Missouri Pacific Railroad subsidiary, has inaugurated a chassis pool to insure availability of a supply of wheels for containers in intermodal service anywhere on the MoPac system.[36] Chassis will be available for distribution from New Orleans, Houston, Kansas City, and St. Louis in order to minimize backhaul problems. Thus, pools of intermodal equipment can be expected to develop on regional and global bases to meet the need for efficient, economic service.

While the practice of leasing offers many advantages, the cost to the leasee is frequently a deterrent. A director of a large trucking company claims it costs his firm $8.50 daily for a 40-foot container (and chassis) against $3.00 for a 45-foot domestic trailer.[37] A trucker will not haul a trailer from port to an inland location to pick up a load for foreign shipment unless he can carry revenue producing goods going to the same inland pick-up area. He is not willing to pay a per diem charge on an empty haul just to get a return haul to the port city.

Lease charges are especially burdonsome in an export movement, for example, which might span 40 days of per diem fees; these are only partially offset by carrier allowances.

As an example, the published lease rates of XTRA, Inc. for 20-foot aluminum and steel containers are as follows:[38]

Day by day lease	$ 2.00 per day
Round trip lease	1.75 per day
One year lease	47.50 per month
Eight year lease	29.00 per month

Container Transport International offers the same per diem rate. A return charge of $50 is levied for equipment returned to the CTI depot from which it was acquired; this may be done without advance notice and the Per Diem Plan can be converted to a Term Lease Plan at the option of the leasee.

Interpool, Inc., a subsidiary of REA Express, offers a term lease plan based upon the shipper's use.[39] For a 10 year lease on a minimum of 500 aluminum or steel ISO containers, the annual charge would run from $237 for 40 percent utilization to $310 for 100 percent utilization. Billings are made quarterly in advance at the 40 percent utilization rate, with adjustments based upon previous quarter use.

The Equipment Interchange Association (EIA) was established to "foster, promote, encourage and improve equipment interchange . . . between and among common carriers of freight both domestically and internationally."[40] The association has immunity from anti-trust laws under the ICC Act in establishing uniform per diem charges for intermodal equipment exchange service. It publishes rules and regulations under which participating carriers operate, as well as a registry of intermodal trailer and container equipment. Through cooperative effort on the part of carriers associated with such organizations as EIA and through individual enterprise, motivated by improved profits, there are expectations that the practices of leasing and pooling will contribute much to the furtherance of containerization.

Container Interchangeability: Standards

Considering all the modes of transport by air, rail, highway and water, there does not exist a truly intermodal container, nor is one likely to be available soon. The reason: each mode has certain restrictive criteria which must be built into the containers to be acceptable. For example, tare weight to cube ratio is important in air; strength for stacking as many as six high and sidewall strength to resist rolling are needed on the high seas; maximum allowable cube is needed by the motor carriers; and ability to resist "g" forces in humping are required for rail movements. Is it any wonder that 200 different sizes and types of containers were reported in service in the United States in 1962?[41] Is it any wonder, also, that large fleets of nonstandard containers have come into existence to meet the needs of individual carriers operating in comparatively restricted geographic areas, where they may be subject to local regulatory requirements?

As far back as 1935 a report of the Committee of Federal Coordination of Transportation called for the standardization of equipment for the "uniformity of operations in the everyday handling of containers." A report prepared for the same committee 26 years later (in 1961) noted that progress on standardization of containers had been remarkably slow and that some writers were still advocating a "go-slow" policy in order to allow further development of the art.[42]

History of Container Standardization

References to various steps taken in arriving at current container standards are scattered freely through the literature. Fred Muller, Jr., and John B. Hulse covered the subject well in papers they prepared for one of a series of Workshop Conferences on Coordinated Transportation, sponsored by the American University from 1964 to 1966.[43] An abstract of their comments follows.

As far as the United States is concerned, two organizations have been responsible for current container standards. The first is the American Standards Association (ASA), originally conceived in 1918 and currently consisting of representatives from at least 135 national organizations. The second is the International Organization for Standardization (ISO), which is a federation of national standard bodies from at least 54 nations. The ASA is the member of the ISO from the United States.

In 1958 a Container Standardization Committee was formed within the framework of ASA and was designated the MH5 Committee. Initial subcommittees were concerned with standards proposals for container (1) sizes, (2) handling and securing, and (3) weights and loadings. The size standards of 10-20-30- and 40-foot lengths, with 8 foot width and 8 foot height were quickly agreed upon and issued as MH5.1-1962. The international implications of container standards were soon recognized and an ISO project, referred

to as TC-104 was established with the ASA acting as Secretariat. To a large extent, standards developed by the MH5 committee have been accepted for consideration and are in various stages of approval by the ISO membership.

Container Standards

The adopted standard sizes were described earlier in the review on containers and handling equipment.[44] Strength requirements for the containers have been established through the specification of loading tests for the individual segments, such as the floor, walls, ends, and roof. Tests are designed to guard against failures when the boxes are used in accepted service. For example, the floor must withstand the pressure of a loaded fork truck; the cornerposts must be capable of carrying five fully loaded containers stacked above in containership practice; the walls must retain the load under rolling ship movement; and the ends have to be strong enough to resist the gravitational deceleration caused by humping of railcars in a classification yard. Since the containers are used outdoors, they must also be weatherproof.

Considerable discussion was involved in the establishment of standards to meet handling requirements. The final result was a standard corner fitting which can be used to lift a loaded container from the top or bottom corners, and which will accommodate manually applied hooks and slings or automatic equipment employing twist locks. Many boxes which are of standard size are not interchangeable because they were built before the standard corners were established and thus may not be capable of handling by equipment designed for use with standard corners.

Standards have also been developed to control the markings of containers. Specifications include the location of the owner's marks and serial numbers, code letters to indicate the type, size and country of origin, as well as location of a pocket for carriage of documents.

Standardized terminology has also been developed for use in dealing with containers. It should be noted that the standards work has been limited to the containers themselves, and while it may influence design of handling equipment and rail cars, requirements for the latter are left to coordination by other groups. Copies of the ISO draft recommendations have been published in Jane's Freight Containers.[45]

Containers can be voluntarily certified as meeting the standards requirements under a program established by the American Bureau of Shipping.[46] First, plans are submitted by the manufacturer along with a schedule of testing and quality control. A prototype of the production container is submitted to the Bureau for testing, and finally, if acceptable, a certificate and decal of approval are issued.

The ultimate result of standardization efforts by the ASA and ISO committees, according to one writer,

> will be the establishment of an International coordinated transport system based on a modular series of container sizes which will permit the unrestricted movement of freight containers capable of interchange between the major transport carriers, producing more efficient utilization of transport systems, the coordination of domestic transport facilities, and a significant reduction in the annual cost to both industry and consumer in the distribution of products.[47]

Nonstandard Containers

A discussion of nonstandard containers was included in Chapter II, which indicated that they represent an important share of containers in use and still being manufactured.[48] The reason for this situation is that the United States pioneers in containerization designed their systems to meet local regulatory requirements at a time when international standards had not yet been firmly established. As their respective systems prospered, their commitment to nonstandard boxes grew to a point where only a long-term phasing-out now appears practical. Sea Land Service, Inc., has over 30,000 containers in service with dimensions of 8½ feet by 8 feet wide by 35 feet long. Matson Navigation Co. containers measure 8 ft. 6½ in. high by 8 feet wide by 24 feet long and they were reported to have over 6,000 in service. The 24 foot length was adopted so it could meet double-bottom maximum length limitations for over-the-road movement in California, the base of Matson operations.

The original Flexi-Van containers used by the New York Central were handled on a special flatcar provided with a turntable. They were of standard length dimensions, but without the standard ISO lifting corners and 8½ feet in height. The Southern Railway System employs a bottom lift gantry crane and its original containers, of standard size, did not include standard corner fittings. The largest fleet of nonstandard containers is comprised of United States Army CONEX boxes, but they do not normally travel in commercial traffic.

As an indication of a gradual program to phase-out nonstandard equipment, Sea Land Services has designed its new ships to accept either 35 foot or 40 foot boxes.[49] In addition, over 10 percent of its present fleet is estimated to meet ISO dimension standards.

Governmental Activities

In its recommendations on standardization in 1961, the Doyle Committee proposed that a Department of Transportation (not then in existence) or the ICC be given adequate directives and authority to promote standardization of transportation equipment.[50] It recommended funds be provided for development of standards by an appropriate agency, such as the National Bureau of Standards. It further proposed that Government shipping agencies be directed to favor carriers offering standardized equipment, where appropriate to the movement desired.

Generally speaking, the Federal Government has taken a "hands off" attitude toward involvement in the establishment of container standards. However, in order to qualify for subsidy, United States built containerships must be designed to handle ASA specification containers.[51] In the opposite vein, a recently enacted law (P.L. 90-268) prevents government agencies from dictating standard sizes of containers. In testimony before Congress on the bill, the ICC urged that the Department of Transportation was the most appropriate government agency to promote greater uniformity in container sizes through voluntary action among the various carrier modes.[52] Little action in this area by DOT is thus far evident. It is interesting to note that "container inspections" by the Federal Maritime Commission involve an examination of the <u>contents</u> of loaded containers to establish whether the goods are being properly declared for rate determination.

Governmental agencies do provide some assistance of a coordinative and advisory nature, however. As an example, the Maritime Administration sponsored an Automatic Container Identification Conference, "to acquaint the maritime industry with a technologically advanced approach to equipment identification and control and to promote a climate of intermodal cooperation."[53] Existing optical scanning equipment in use for keeping track of piggyback trailers was discussed, as it relates to possible use for containers.

Problems Related to Standardization of Containers

The underlying purpose of container standards is the development of international intermodal common denominators which promise economic benefits to all those involved in their use. In addition to reduction in rehandling of goods, standardization is expected to promote coordination of through transportation systems, including the reduction of documentation requirements and the establishment of through rates. The promise of these benefits is recognized but standard containers fail to meet the needs of all shippers. This situation is rather forcefully presented below by a trucker who was participating in a panel discussion on containerization.[54]

> What about the trucker, we need 8-ft. [high] containers like we need holes in the head, because when we get two 20-ft. containers put together, . . . whether on a chassis or hooked together, we lose 5,000 lbs. of payload, and we lose 18 per cent of our cube. And we run this pair in two directions . . . we got to move another load in another direction because nobody pays us [for a deadhead return]. The railroads have the same problem--not as severe as ours--but they face the same problem.
>
> And yet the steamship lines and the people in Europe say it has to be 8-ft. because they have certain limitations for their railroads--not because of the truck limitations in Europe; they can handle 8-ft., 6 in., but because of the rail limitations the railroads aren't even prepared to handle containers yet.

An ironic twist on the above comments is a recent decision by the German Federal Railways to use containers 6 cms. wider than the ISO standards in order to accommodate optimum loading of European railway pool pallets.[55] These

pallets are widely used in the shipment of foodstuffs in the Common Market. They are almost 32 ins. by 48 ins. (800 x 1200 mm) and do not quite fit in an 8 foot wide trailer whether positioned two crosswise or three in the long direction.

Pressures have been generated to supply containers up to 9 ft. 6 in. in height. The air carriers propose lighter weight containers with reduced rated load capacities; they claim the high density items justifying high container weight capacities do not move in air freight. Only local regulations against trailers wider than 8 ft. in most of the states are restraining demands for 8 ft. 6 in. wide containers. Special interest groups prod the legislators against relaxing rules in the interest of safety while ignoring the fact that hundreds of 12 foot wide house-trailers are moved over the highways every day. With combination trailer over-the-road length allowances being eased up to 65 feet, pressures are developing for 27 foot containers to be used in double-bottom movement.

Design of over-the-road trailers is limited primarily by the most restrictive highway regulations in the territories where they are expected to be used. Design changes can be easily adopted to meet changing regulations; not so for container standards. The route between the initial proposal of a standard and final preliminary acceptance is lengthy and involved. Further, the container

standard must meet the most restrictive limitation of all modes, whereas the trailer is faced with road requirements, only. Thus, the trucker is reluctant to integrate standardized containers into his domestic operations or to control them for more than short periods of time.

It can be expected that standard intermodal international containers will continue to increase in number. At the same time, containers for domestic movements are likely to be designed to meet strength and safety requirements, but to be modified for economic reasons and special application purposes. Unfortunately, this trend will retard development of interchangeable container pools.

Labor Problems

The technology of containerization is directed toward the achievement of increased productivity through reduced handling of goods in shipment. Increased productivity is obtained by using less labor for moving a given volume of goods or by moving more material with the same labor force. The historical pattern of such developments is an early contraction of the labor pool, followed by expansion as the increased productivity generates additional business. Faced with the prospect of loss of membership, labor unions tend to resist innovations which increase productivity, but the inevitability of the change impels them to make an accommodation in order to share in benefits

of the new technology. Porton stated that the goal of labor-management relations relating to containerization is to strike a proper balance between <u>efficiency</u> in cargo handling and <u>concern</u> for the manpower charged with handling it.[56] Concern includes such matters as safety on the job as well as the welfare of those displaced.

The literature on labor problems involved in implementation of containerization and intermodal freight coordination can be divided roughly into two areas: (1) piggyback operations involving rail and truck unions, and (2) port activities which are dominated by longshoremen, but including jurisdictional disputes with truckers at the port interface. Most of the groundwork for present labor agreements on piggyback operations was developed in negotiation during the 1950's, when the art was in its early growth stages. Likewise, most of the bases for present labor agreements concerning containerization on the docks were achieved during its early growth period in the 1960's. Negotiations recur in both areas as contracts expire, but the basic attitude of labor is to share in the benefits of the new technology which increases productivity and to provide protection for workers who are displaced.

Labor Attitudes Toward Inland Freight Intermodal Traffic

Labor attitudes toward inland freight intermodal coordination (primarily piggyback) are reviewed first because they bear more closely upon the main concern of this paper, namely developments in the domestic area. Activities at the port interface will also be reviewed because the growth of the use of containers in marine shipments is influencing growth in domestic traffic. Much of the foreign trade originates or is consigned to inland destinations which require movement by highway and rail.

In his study of problems and potentials of intermodal freight transportation coordination, prepared for the United States Department of Commerce, Roberts devoted a chapter to the effects of trade union policy. The emphasis was primarily on TOFC services involving highway and rail unions. Most of this review is abstracted from his work. Based upon interviews with representatives of labor, management, and government, he offered the following summary:[57]

> The Teamsters Union, as a national organization, has interposed only insignificant obstacles to the trucking industry's coordination efforts. The lack of opposition appears to stem from a combination of economic constraints, union impotence, and union leadership decisions.
>
> The policies, attitudes, and behavior of the railroad unions have not impeded containerization and coordination. The reasons for this are similar to those governing the Teamsters' behavior, plus the fact that railroad employees have largely benefited from these changes.

> Government policy on labor relations within the trucking and railroad industries has had no substantial productivity or cost implications that might affect coordination adversely.

A complicating factor in labor relations involving piggyback activities is the fact that responsibility for ramping and deramping trailers, tying and untying them to flatcars, and delivery or pickup at shippers' docks varies with the type of plan in use. If the work is done by members of the Teamsters Union they are subject to the Taft-Hartley Act; if done by members of one of the railroad brotherhoods they are covered by the Railway Labor Act. Early disputes as to which craft or classification should be assigned the work (within a given union) have largely been resolved with the passage of time.

Since the railroad union membership generally benefitted from piggyback development they had little reason to impede its growth, so the discussion is centered primarily on relationships with the truckers. For all practical purposes, the International Brotherhood of Teamsters (IBT) is the only labor union involved in <u>common</u>-carrier trucking. Influencing their bargaining position is the ever-present threat of competition from the railroads and private carriers, whose drivers generally are nonunion or who belong to other unions. Since common carriage trucking is a regulated industry, the unions also share in management concern over legislative developments which might restrict their activity. These factors were important in influencing truck

union leadership not to prohibit motor freight carriers from engaging in piggybacking in the early 1950's. However, the unions were concerned that piggybacking would get the trucks off the highways and thus would threaten trucker jobs.

During contract negotiations in the Midwest Territory in 1959, the union agreed that an employer may use piggyback services when his volume of business exceeds the volume that can be normally handled by his present driver force.[58] Employees laid off because of piggybacking were assured compensation in the form of severance pay and re-employment rights based upon seniority. The number of employees that could be laid off was limited by the contract. Agreements signed after February 1, 1962 required that "for each trailer or container placed on, or delivered to, rail flatcars, birdyback, fishyback, or barge operations, the sum of five dollars ($5.00) shall be paid into the Pension or the Health and Welfare Fund as the Union may direct."[59] Enforcement varies according to agreements in local contracts.

The most influential argument used to persuade the union to accept piggybacking was the assertion that it would not lose membership. Events have justified these claims. For every displaced over-the-road driver, additional workers have been hired for loading and unloading trailers and for local pickup and delivery due to growth in demand for truck service.[60] As a result, there has been little labor problem from piggybacking.

Perhaps the biggest problem area with piggybacking, as it involves <u>rail</u> unions is the matter of "make-work" rules covering freight movements in general. The problem is highlighted in the operation of an integrated intermodal train, the Santa Fe's "Super C," which requires the services of 18 separate train crews on its 2,200 mile, 40 hour run between Chicago and Los Angeles.[61] Outmoded work rules established a 100 mile work day for crews. Present scheduling finds certain crew members completing their "day" in about an hour and a half. Railroad management argues that the combination of "make-work" rules and spiraling wage costs threaten the same fate of decline for freight trains as has occurred in passenger service.

In conclusion, it appears that resistances of labor to the innovations of piggyback and containerization have not been important factors in limiting growth of strictly domestic intermodal freight movements. However, domestic traffic also includes inland movement of international freight shipments. The literature pertaining to labor activities at the dockside interface will be reviewed next.

<u>Labor Attitude Toward Containerization at the Docks</u>

Union negotiations involving dock labor handling import and export trade have also been influenced by two basic considerations; namely, (1) a desire to participate in the economic benefits derived from increased productivity generated through containerization, and (2) protection of workers displaced as a result of the increased productivity. The current literature relates primarily to agreements and activity involving dockside workers because marine container technology is still changing rapidly and growth is much more dynamic than presently enjoyed by inland piggyback traffic. In addition, the benefits to be shared between business and labor are comparatively greater when break-bulk ship loading is replaced with containers.

Dock workers on the United States Pacific Coast are organized by the International Longshoremen's and Warehousemen's Association (ILWA), while the Atlantic and Gulf Coast ports have waterfront labor agreements negotiated by the International Longshoremen's Association (ILA). Bargaining by these two unions has followed separate paths to achieve the same general objectives mentioned above. They have also made loose agreements with the Teamster's union (IBT) with respect to jurisdictional responsibility in loading and unloading (stuffing and stripping) containers at dockside locations.

The ILWA set the course for dockworker acceptance of containerization on the West Coast when it signed a "Mechanization Agreement" with the Pacific Maritime Association (a carrier group) in October, 1960. The philosophy and developments which led to this agreement were recounted by Harry Bridges, head of the ILWA in a seminar held by the Federal Maritime Commission in Washington, D.C. in 1967.[62]

The agreement stipulated that no man could be laid off because of mechanization; he had to be retired with a pension if no longer needed. A 35-hour work opportunity guarantee was included. A tonnage charge for containers handled was levied, which accumulated to over $13 million within five years. The fund currently provides a man retiring at age 62 with at least 25 years service with a lump sum payment of at least $13,000, plus additional benefits, and regular monthly pension payments beginning at age 63. Bridges claimed that although job assignments have changed, some thousands of jobs have been added to the industry since the agreement was signed.[63]

A Container Freight Supplement agreement was recently reached with the Pacific Maritime Association in which the ILWA is guaranteed to have within its jurisdiction by June 30, 1971 the stuffing and stripping of all containers, except for manufacturers' loads.[64] The work, to be performed at container freight stations at or near the docks, will be done by workers supplied by ILWA hiring halls. Justification for this agreement is based upon longshoremen's contention that the container is merely a portable piece of the ship which can be moved around and worked away from the ship.

Recently a representative of the Transportation Association of America wrote to a number of shippers and carriers and asked for an appraisal of the labor situation.[65]

No serious roadblocks were claimed to exist on the West Coast; no complaints were received from the Middle West, and few about the Gulf Coast ports. On the other hand, many complaints of roadblocks by dock labor on the East Coast were registered. Among situations itemized were:

> Insistence of a full 18-man longshore gang for each crane used . . . this work can readily be done by 10 or 12 men.
>
> Present ILA agreement requiring stuffing and stripping of containers of LCL cargo by ILA personnel if done within a 50-mile radius of East and Gulf Coast port cities . . . at a higher rate than warehouse labor.
>
> Continuation of the practice of stopping work while a light rain is falling . . . such stoppages were formerly ordered by management to protect cargo from water damage. Weathertight containers now protect the cargo, but longshoremen still knock off for even a light rain.

In New York, a "containerization royalty fund" was set up in 1960. The amounts paid into this fund by the waterfront employers ranged from 35 cents per ton of containerized freight handled on a conventional ship to $1.00 per ton on a ship in large measure converted to container fittings. In 1965 a contract change provided for somewhat smaller work gangs and more flexible work assignments.[66] Job and income guarantees and supplemented retirement benefits are provided to union membership.

In a recent speech, Thomas W. Gleason, President of the ILA voiced concern over the effects of continuing technological changes on dockworker job security.[67] He singled out the development of the lighter-aboard-ship

(LASH) service as an example, where a full day's work for a longshoreman crew can be reduced to 15 minutes. His philosophy is that management should treat the cost of providing security for displaced workers as a long-term investment.

The recent literature itemizes more costly agreements for handling containerized freight at the docks. The New York Shipping Association recently concluded an agreement which was opposed by the Port of New York Authority; it would raise penalty charges for handling containers from the then current $1.50 per man hour to $2.07 per ton (about a threefold increase).[68] In May, Gleason announced that all containers would be stripped and reloaded on the piers pending renegotiation of the ILA container contract with the New York Shipping Association.[69] Under existing contract the NYSA had agreed to a penalty of $250 per container if less than full containers were consolidated away from the piers. The union claimed that provisions were not being policed and rejected a reported offer of $1,000 per container penalty.

In summary, dockside labor agreements have added to the cost of marine transfers of containers and any slowing of growth in this sector will reflect in reductions in domestic movements of import-export traffic. Conversely, containers and wheeled trailers are viewed alike by truck and railroad labor. Piggyback development has settled down to a point where labor resistance does not appear to be an

important factor in retarding growth of containerization in domestic shipments.

Government Regulation

The literature review discussed in this section will relate primarily to regulation of transportation by the Federal government as it relates to the growth of containerization. This is not to infer that activities of the various state regulatory commissions have been without effect in retarding growth of containerization in domestic freight shipments. On the contrary, for one example, the decisions of Sea Land and Matson to adopt container sizes which are now considered "nonstandard" were prompted by limitations in over-the-road movements of the boxes as established in state regulations. However, the main concerns of state regulations involve load limitations and container size limitations. Their future effect will be determined by whether or not the trend is continued toward relaxed requirements as improved highways are built.

The agency whose regulation is most influential in the domestic sector is the Interstate Commerce Commission (ICC).[70] The Civil Aeronautics Board (CAB) has regulatory authority at the intermodal air interface, and the Federal Maritime Commission (FMC) takes over at the ocean interface. Since development of containerization in marine transfers is providing a catalyst for a buildup of infrastructure to handle the movement of boxes to inland destinations, the

actions of the FMC have a definite effect upon the growth of containerization in domestic traffic. On the other hand, air movements are still essentially limited to the smaller IATA contour "Igloos" and similar containers; regulation of truck transfers from air terminals has not had any significant limiting effect on growth of domestic containerization.

Although presumably guided by a common document in the form of the National Transportation Policy,[71] the existence of three separate regulatory agencies has been subject to criticism because of jurisdictional disputes, interagency disagreements in specific areas of transportation policy, and to actions by one regulatory agency without regard to the effect on modes of transport regulated by another agency. These problems have led from time to time to recommendations for combining agencies, or at least to providing coordinative activity, such as was proposed in the Doyle Report.[72] An outgrowth of these recommendations was the establishment of the Department of Transportation (DOT) in 1966. Among its stated purposes, that one which is of greatest interest to this study is the assignment, "to facilitate the development and improvement of coordinated transportation service, to be provided by private enterprise to the maximum extent feasible."[73] Also important is the assignment "to stimulate technological advances in transportation." Initial efforts have been aimed primarily at unsnarling congested systems

for moving people--mainly the intercity highways, and the development of rapid mass transit systems. However, the Office of Facilitation has studies under way which are intended to help in further development of container traffic.

Regulation of Piggyback

The history of regulation of containerization is bound up in a series of cases and decisions of the ICC. Highlights of a few "keystone" cases in the development of today's regulatory structure will be presented. The first key case, ICC No. 21723, In the Matter of Container Service, was decided on April 14, 1931.[74] The ICC denied continuance of container rate charges based upon weight and distance without regard to the nature of the contents, stating:

> We cannot approve varying rates based on the weight of the lading offered for container shipments except upon a record which established that charges so determined are warranted by differences in the cost and quality of the service.

This decision effectively terminated piggyback container service, which had just begun to grow in popularity because of the economies of "freight all kinds" rates being offered. The Doyle report commented on the decision, stating that it had effectively caused an end to container service for that period because shippers were not interested in the freight classification rates proposed by the ICC, and that economy was denied in favor of compliance with rate tradition.[75]

In 1936 the Chicago Great Western Railroad published tariffs for a "substituted service" and for coordinated rail

and motor service, which were to become Plans I and V, respectively. In "substituted service," the motor carrier substitutes TOFC service over part of the route. These tariff publications were approved by the ICC.[76] The ICC later conducted an investigation and established rules for substituted service <u>if the shipper authorized</u> such substitution.[77] Piggybacking finally became an accepted, established practice following the ICC decisions in the New Haven case.[78] The New York, New Haven & Hartford Railroad Company submitted a list of questions to the Commission aimed at clarifying regulations, limitations, and obligations related to piggyback service. Among the principles set forth in the decision were (1) the right of railroads to transport trailers of private and common motor carriers and forwarders, subject to specific regulations, and (2) the requirement to provide service to forwarders if it were also offered to private carriers. The decision provided guidelines which encouraged carriers to procure equipment and expand piggyback service.

After rendering a number of decisions relative to the lawfulness of the various piggyback plans as they were developed, the Commission initiated an investigation referred to as Ex Parte 230.[79] It handed down a decision in the form of eight rules with subsections. The decisions were appealed to the Federal Courts by the carriers and forwarders affected, and the ICC postponed the effective

date of its proposed rules, pending ruling by the courts. One of the rules required that each railroad offering TOFC service be made to file the charges governing the leasing of its equipment (including trailers). This led to the development of Plan II½ as a replacement for Plan III.[80] Another rule forbid the use of substituted service by common carriers where the piggyback section is less than 85 percent of the total route.

There have been many more cases argued before the ICC and the Federal courts, but the above-mentioned cases have been generally responsible for setting the path for development of piggyback service, both for containers and trailers. As a general overall observation, the cases relate to (1) the acceptance of proposed rates, (2) limitations as to who may or may not participate in given service arrangements, and (3) specification of the details of service which may be allowed or denied.

Limitations of the Regulatory System

The three major regulatory agencies have their respective domains of authority in the areas of air, marine, and domestic surface movements. Weaknesses in the regulation of intermodal activity are most apparent at the interfaces because of overlapping authority and gaps in coverage. Historical development of transport regulation has not been aimed at achieving a coordinated, unified system. As one writer states,

> [Government policy] has tended to deal with the different modes according to the exigencies of the moment, rather than as parts of an integrated system. We have, then, a loose grouping of individual industries separately regulated and favored and sometimes operating without due regard for balanced development in terms of the overall needs of the economy.[81]

Illustrating overlapping authority, he singled out laws governing intermodal transfers between the United States mainland and Alaska and Hawaii "applicable to identical traffic moving on identical carriers serving identical points but regulated differently depending upon whether or not through arrangements have been made by the carriers." Arrangements would determine whether FMC or ICC would have jurisdiction.[82]

Ultimate maturation of intermodal traffic, especially that involved in door-to-door movements including foreign commerce, requires the development of through routes and joint rates. A unilateral announcement by the ICC that it would accept joint tariffs between ocean and land carriers led to a jurisdictional squabble with the FMC.[83] The matter was resolved when the FMC agreed to allow ocean carriers to participate in such rates, provided that tariffs clearly "break out" the shipline's division of revenues.

In recognition of coordinative problems of regulation involving intermodal transfers, both in foreign and domestic trade, the newly formed Department of Transportation submitted a Trade Simplification Act of 1968 to Congress for consideration; it has not yet been adopted.[84]

The law was intended to remove uncertainty in regard to regulatory laws and anti-trust laws relating to carriers' rights to engage in joint rates, interchange of equipment, and through bills of lading.

An example of a gap in coverage is the limited regulatory authority available to require establishment of through intermodal rates. The ICC has authority to require through routes and joint rates between rail carriers and inland water carriers. It may approve but cannot require such agreements involving motor carriers among themselves, motor and rail, or motor and water carriers. Likewise, there is no authority requiring joint rate and/or route agreements between air/motor, rail/ship or motor/ship modal transport combinations. Legislation has been proposed by the CAB, the FMC, and the ICC to create a new joint board comprised of one member from each agency to process through service and joint domestic rates of any combination of air, water, and ground carriers, where such rates are not subject to individual agency jurisdiction. Legislation has also been proposed whereby the ICC may require the establishment of joint rates in areas not now covered, such as motor/rail.[85]

Another recognized weakness of the regulatory system is the limited provisions for planning. A quotation by one of the ICC commissioners is enlightening:[86]

> As I see it, the ICC has no direct responsibility to develop or promote containerization. . . . I do so mostly on my own time--nights and weekends--with no prospect of personal benefit.

Underlining the need for coordinative leadership, he stated,

> This problem can only be solved through establishment of an integrated transport system, involving close cooperation between shippers and between operators of trucks, railroads, barges, and ships--a type of cooperation which today's attitudes and prevailing intense intermodal conflicts make difficult. . . . For the most part present planning for domestic movements of container traffic is on a strictly intramodal, "go it alone" basis.

He concludes, without telling how we will get there,

> The key to success is not to be found in singlemode enthusiasm for obtaining a competitive advantage over all other modes on container traffic. Real success--success which is in the public interest--will come only to the extent that we coordinate all modes of carriage into an efficient carrier "system."

The Department of Transportation was created in recognition of the need for a coordinating, planning agency. However, the fragmented regulatory structure which still remains has prompted proposals for change. The CAB chairman is reported to favor a single agency combining authorities of the CAB, FMC, and ICC. The President's Advisory Council on Executive Organization has made a similar recommendation, although it is reported to have had a cool reception by the White House staff.[87] A team of consumer-advocate Ralph Nader's investigators likewise proposed a single agency. In a 1,500 page report, Nader's team contended that the ICC is preoccupied with settling disputes among private transportation concerns instead of looking out for the public interest.[88] Perhaps the problem is best summed up by R. J. Barber of the DOT, who stated,

> All things considered, a regulatory scheme that evolved in a period when transportation modes were readily classifiable into air, rail, marine and motor may simply not be in tune with the technology of the last third of the 20th century.[89]

Conclusions Concerning Government Regulation

Regulation of the country's transport system through three major governmental agencies does not appear to be an optimum arrangement. Divided responsibility has impeded innovations in intermodal practices. Establishment of the Department of Transportation with responsibility for promoting development of the transport system appears to be a step in the right direction, but the problems of fragmented regulation remain.

The container revolution has been a major force in blurring modal boundaries. Mounting pressures for reorganization of regulatory authorities into a structure designed to cope with today's transport needs may result in formation of a body which will provide both regulation and coordination of all modes into an efficient carrier system, as spelled out by Interstate Commerce Commissioner Walrath. Intermodal movements of containers can be expected to provide the linking pins in such a system.

Multimodal ownership by individual carriers also comes within the regulatory agency province but it is of sufficient interest in considering intermodal activities that it is given separate treatment in the next section.

Multimodal Ownership Limitations

Multimodal ownership by individual carriers has been proposed as one means of achieving efficient systems which bridge the intermodal interfaces. Resistance to such a trend is provided by the Congress and the regulatory agencies. Opposition to the idea of multimodal ownership seems to be promoted by two basic fears: (1) in a given area such a company could establish control of transport facilities so as to enjoy a captive market and (2) the management of such a company would consider one mode as dominant and would restrict development of other modes under its control, thus restricting service to the public.[90] Because of their vast capital resources, the railroads are the mode generally feared as being capable of swallowing other modes (particularly the trucklines).

The Motor Carrier Act of 1935 and the Transportation Act of 1940 were interpreted by the ICC as giving to the Commission the authority to limit rail ownership of motor trucking. Before 1935 the railroads could have entered any field of transportation without approval of the ICC, except in some cases covered by the Panama Canal Act of 1912. Those few railroads which did enter into the motor trucking field were protected by grandfather clauses and today have subsidiary motor carrier certificates. A few railroads have obtained certificates for limited motor operation in supplemental service. On the other hand, liberal interpretations

are applied where inland water carriers desire to acquire a motor carrier. Likewise, other modes are not restricted from purchasing railroads, although the practice is quite limited.

An example of a multimodal ownership operation retained under grandfather clauses is the Missouri Pacific Railroad and its subsidiary trucklines, which operate over 17,000 miles of interstate certificated rights.[91] Coordinated transportation has permitted Missouri Pacific to compete in and reverse the downward trend in less-than-carload tonnages. They employ Plan V joint rates over the through routes served. Multimodal ownership has allowed for coordinated sales, pricing, and other functions, such as billing and collecting. Experience in captive coordinated service may have been a factor in development of the MoPac CONTAINERPAK plans for shipping by container.

An interesting analysis of alternatives to present regulatory practices which included the possibility of "transportation companies" was developed in a background paper for a conference held at the Brookings Institute in December, 1967.[92] Advantages of establishing transportation companies of multimodal nature were offered as follows:

> Such companies should be able to coordinate intermodal services and provide a more efficient package of transport services to the shipper than could be achieved under the existing separation of the modes. Moreover, by permitting the substitution of trucking for rail services, transportation companies could enable the railroads to achieve a more efficient scale of operation

> and thus eliminate one of the major costs of current regulatory policies . . . [they] should be able to coordinate rail and trucking services better than could rail and trucking operations acting independently. Periods of excess investment . . . would be less likely to occur.

It was recognized that since railroads are the corporate giants of the industry it is likely that they would do the acquiring of other modes if unrestricted.

In the ensuing conference the participants agreed that transportation companies offer great potential to eliminate excess capacity, to offer better service, and to reduce transport costs by coordinating and integrating the various modes.[93] However, there was little faith in railroad management's ability to take advantage of possibilities for such improvements. Secondly, there was concern that railroads would dominate and neglect potential developments and innovations in other modes. Third, there were no assured ways that independent firms could be treated with parity in obtaining integrated services from the transportation companies and thus could not remain competitive. Possibilities of acquisitions by nontransport companies and doubt of continued competition were also raised. As an alternative to transportation companies, several participants proposed the development of transport brokers, similar to the nonvehicle operating freight forwarders. However, their possible impact was considered inadequate to the needs for reorganization of the transport system and its regulation.

The Canadian Pacific Railroad is a multimodal operation controlling rail, motor, air, steamship and pipeline modes. In discussing advantages of such a system, a writer recently mentioned benefits relating to new technology which are of importance in development of containerization.[94] He said,

> The increasing sophistication of multimodal transportation systems places a premium upon the utilization of complex transfer devices, as well as basic freight vehicles that are compatible between all modes. Vested interests of certain transport modes, the inability to secure agreements regarding the hardware of inter-modal equipment and facilities, as well as the practical difficulties of reconciling the differing interests of dozens of firms in the various modes, all suggest that the single transportation firm, reaching across all modes, is uniquely suited to hasten the introduction of multi-modal technology.

The current literature abounds with argument pro and con on multimodal ownership of transport companies, with the railroaders generally for it, truckers against it, and others positioned according to their special interests. This section of the literature review will wind up with a few quotations which serve to illustrate the point.

The Acting Chairman of the ICC stated recently,

> There are different views on the relative proficiency of an integrated transportation company that could be formed if common ownership were permitted, as against separate and independent transportation modes working in harmony in a multi-modal arrangement.
>
> At this juncture the ICC consistently has been in opposition to changes in the law restricting railroad ownership or control of other modes. . . . Requirements for independent ownership of the transportation modes <u>does not</u>, in my opinion, <u>retard containerization progress</u>.[95]

A man who looked at transportation both as a participant and as a regulator was quoted as saying,

> Intermodal transportation systems under one management, designed around the phenomenon of the container . . . are the key to domestic distribution efficiency of tomorrow. Our present compartmentalized system of transport . . . can only work against the orderly growth and development of domestic container traffic. I believe . . . that most of the problems of coordination and pricing of domestic intermodal transportation services would disappear if common ownership of transportation systems were authorized.[96]

Finally, a railroad executive who later took an administrative position with a trucking firm stated, in answer to a question on barriers to intermodal cooperation,

> I think the principal barrier is that no one really sells intermodal operation. Carriers make intermodal arrangements, but then none of those participating in the intermodal tariffs really goes out and sells it. Each one is trying to sell his own mode. . . .[97]

Intermodal ownership would be expected to promote greater opportunities for through service. Additional factors which influence intermodal integration are reviewed next.

Factors Relating to Lack of Through Service

Containerization is just one of the new equipment and procedural concepts that is being installed throughout the transport common carrier industry today. In an overall view, these innovations are aimed at integrating the operations of the carriers with the needs of the shippers into an

effective economic physical distribution system. "Door-to-door" through shipment service at minimum time and cost is the goal, whether the trip be entirely domestic or international in scope. Although progress is being made toward the goal, some areas of concern remain which require attention in addition to those already discussed in this literature review. As with previously mentioned factors, regulatory practices, technological development, and limitation of capital funds influence the rate of progress.

The railroads spend relatively little on research and development. They have been particularly slow in adopting innovations. For example, the time period elapsed between a 10 percent and 90 percent acceptance of an innovation in the rail industry has been 6 years longer than in the steel industry and 14 years longer than in the brewing industry.[98] Evidence strongly indicates that the rate of innovation has been stifled by the regulatory process. The same observations can probably be applied, at least qualitatively, to the other modes, which are likewise subject to regulatory control.

The Land Bridge Concept

An example of slow adaptation of an innovating concept is the land bridge proposal which has been discussed for some years. The idea combines the use of containers and integrated unit trains so implemented as to provide for rapid crosscountry carriage of goods. The original intent

was to provide a land bridge across the United States for shipments from Japan to Europe, bypassing the Panama Canal, to achieve a savings in time and distance traversed. With the advent of faster ships today, and with the projection of still faster cargo ships in the future, the expected time advantages begin to disappear.[99] The need for intermodal transfers at East and West Coast docks plus possibilities of missed connections due to schedule slips are factors which reduce attractiveness of the proposal.

On the other hand, the idea of "mini-bridges" appears to have merit. Proposals have been developed which indicate that containerized unit trains can provide fast efficient service when moving between the East and West Coasts, the Gulf areas, or when terminating at inland destinations, such as St. Louis or Chicago. The Union Pacific and Norfolk and Western have developed a joint plan to move <u>international</u> container traffic from Seattle to Norfolk. Likewise, the Sante Fe and Penn Central worked out an agreement to handle containers between California and Atlantic ports on a five day schedule in each direction. A factor limiting these offerings to "foreign-to-foreign" shipments is that the ICC does not have regulatory authority and rates can be obtained on a straight contractual arrangement between the railroads and steamship lines.[100] For an all domestic service, a containerized unit train proposal was developed to move on 4 to 5 day schedules between California and the East Coast, carrying fresh vegetables and/or canned goods eastward and suitable manufactured goods on the return trip.[101] Advantages to the shippers include reduced in-transit inventory costs and improved shelf life for perishables. Of benefit to the railroads, unit trains can be moving in revenue service up to 80 percent of the time, as compared to an estimated 10 percent of the time for conventional trains.

The technology exists for effective land bridge crossings of the continent with dedicated container trains. Logistical support in the form of transfer equipment and container marshalling yards is not yet complete. Container pools to equip the trains are still too lean in some locations and nonexistent in others. Beefing up of the required infrastructure requires capital funds, which are not readily available to the rail carriers because of their poor stature with investors. In addition, resistance to change also prompts such actions as the requirement of chassis under containers moved by most of the eastern railroads. Unless special arrangements have been made, containers arriving in Chicago from the West will be unloaded from the flatcar, placed on a chassis, and reloaded before moving eastward. A deadhead container return is also likely to be mounted on a chassis. Such wasteful practices are inhibiting growth of containerization in both domestic and foreign trade.

Liability and Documentation Problems

Requirements of excessive documents to accompany container shipments and limitations in coverage and assignment of responsibility for losses in transit also inhibit containerization, but the effects are more noticeable in foreign traffic. Just a few of the papers required in a given shipment include a bill of lading, dock receipt, insurance certificate, certificate of origin, delivery instructions, government bill of lading, export documents, and in some cases, consular documents. The package can amount to as many as 90 copies, costing an average of more than $160 per shipment, just for the paperwork. In an effort to obtain relief from the problem, a group of interested participants formed the National Committee on International Trade Documentation (NCITD).[102] After over two years of coordinative effort they have designed a single sheet international intermodal shipping format and are now promoting its acceptance. They have also been successful in eliminating the need for a Shipper's Export Declaration in about 90 percent of the cases where it was formerly required.

The NCITD is currently involved with the Department of Transportation in a world-wide international trade document study. This involves a computer assisted listing and classification of every piece of paper associated with a given freight movement, from the time the order is received until the cargo is delivered at its final destination. It is expected that guide-lines will be established for documentation simplification; the changes should be beneficial for domestic container movements as well as in foreign shipments. Simplified documentation is considered a requirement to meet the needs of through billing, through rates, the computer revolution, and the container revolution.

In the matter of carrier liability, it is recognized that containerization provides significant reductions in claims due to loss or damage in transit.[103] However, while the container prevents damage, it also hides damage in transit. In intermodal transfers the problem becomes one of establishing responsibility against one or more of the carriers for a claim by the shipper. In the case of theft, the whole container may be lost rather than just a portion of the cargo.

In marine transfers the amount for which a shipowner may be held liable for loss or damage to cargo is limited by the Carriage of Goods by Sea Act of 1936 to $500 per package or customary freight unit (also known as the "Hague Rules," originated in 1924 at a world conference).[104] Some steamship companies maintained that the container is the package and thus liability is limited to $500. After an international conference in Brussels in 1968 the limit was raised to 90¢ per pound, or $662, whichever is greater. The carrier and shipper must agree on whether or not a container should be considered a single package and rates are adjusted accordingly.

Rail and motor carriers and freight forwarders are subject to Section 20, paragraph 11, of Part I of the Interstate Commerce Act, which provides that common carriers shall be liable to the owner of the goods for full actual loss, damage, or injury caused by the carrier.[105] The Bill of Lading Act fixes responsibility for the loss or damage upon the railroad which issues the contract of carriage to the owner of the shipment, regardless whether the loss occurred on its own line or with some other connecting railroad. The problem of assigning responsibility and determining the amount of liability incurred becomes complicated in an intermodal transfer which may include truck, rail, and marine movements. For protection, a shipper may obtain a policy with warehouse-to-warehouse "umbrella coverage." In recognition of the problem, the Department of Defense and the Maritime Administration have joined in funding a study designed to unravel complexities of shipper-carrier liability in intermodal transfers. Study of the legalities of through rates and documentation problems are also included in the project.

Restrictions on Forwarders

Examination of restrictions to forwarders provides a fitting conclusion to the matter of limitations in through service. Several participants at the Brookings Institution Seminars believed integrated transportation could best be achieved through the development of companies that would act as transport brokers and would coordinate use of the various modal services without owning any transport facilities themselves.[106] Freight forwarders were considered the likely candidates for such activities. Some writers have referred to such agents as "transmodalists." Before such arrangements can come to pass, however, certain restrictions to forwarder activities will have to be removed by the regulators.

Under Part IV of the Interstate Commerce Act,

> The term "freight forwarder" means any person which (otherwise than as a carrier subject to Part I, II, or III, of this Act) holds itself out to the general public as a common carrier to transport or provide transportation of property . . . for compensation, in interstate commerce, and which in the ordinary and usual course of its undertakings, (a) assembles and consolidates . . . shipments of such property, and performs or provides for the performance of break-bulk and distributing operations with respect to such consolidated shipments; and (b) assumes responsibility for the transportation of such property . . . and (c) utilizes for the whole or any part of the transportation of such shipments, the services of a [common] carrier.[107]

Among existing limitations, the ICC may deny a forwarder application solely on the ground that existing forwarder service is adequate for the needs of the shippers. Rates must be approved in the same manner as for modal common carriers. Forwarders have been permitted to negotiate special contracts with truckers, but an amendment to Part IV of the Interstate Commerce Act is required to allow them to negotiate for special contracts with the railroads. This would allow them to participate in Plan I piggyback service

n the s
ave bee
ther st
establis
ents i
less-th
contain
ate le
'shippe
'carrie
problem
of the
larger
ates
report
rates

appea
State
vices
a rec
by In
under
tran
inte
in f

on the same terms as truckers. Hearings on such a proposal have been conducted before Congressional subcommittees.[108] Other steps are being taken to allow forwarders freedom to establish joint-rate and through-route arrangements in shipments involving more than one mode. Forwarders collect less-than-carload lots for consolidation into carload (or container) lots and operate on the spread between the two rate levels. Present consideration of a forwarder as a "shipper" when dealing with the carriers, but viewed as a "carrier" when dealing with his shipper customers is a problem. Growth of forwarding has not kept pace with that of the other modes, and relief through ability to negotiate larger rate spreads is indicated as needed. The FMC regulates ocean freight forwarders and has authorized them to negotiate with ship operators in order to obtain favorable rates.

Despite the limitations placed upon them, a trend appears to be developing wherein forwarders are being integrated into corporate alliances with other transport services in order to provide a package service. For example, a recent full page advertisement in the Wall Street Journal by Inter-Freight described itself as a distribution system under single management control providing every surface transportation service required to move freight between interior points in the United States and interior points in foreign countries.[109] The combine includes local drayage,

domestic interline road and rail carriage, consolidation, terminal services, leased-container equipment, water carriage, and destination delivery. Total door-to-door liability is offered.

Finally, participants in a series of workshop sessions agreed that implementation of transport coordination across modes must be in the hands of the carriers.[110] They would have to initiate, develop, and operate the coordinated systems. The participants felt that government responsibility should be confined to removing the obstacles that exist to such implementation.

Conclusions Concerning Through Service

The technology exists for implementation of the land bridge or container train concept to domestic transport. However, the infrastructure is inadequate to support such a development except in limited application. Lack of research and development activity by the carriers, as well as lack of support by governmental agencies contribute to the slow progress of innovation in intermodal transport. An example of the type of concerted effort needed is demonstrated by the NCITD work aimed at simplifying documentation requirements.

Forwarders would be in a better position to contribute to the progress of integrated transport if they were less restricted in their activities by the regulatory authorities. The Department of Transportation has submitted bills to Congress which are intended to reduce regulatory impediments to integrated transport. Freight brokerage services may develop as the result of merging of forwarders and other modal representatives into conglomerate organizations.

Summary of the Review of Factors Affecting Containerization Growth

This chapter has been devoted to a review of the literature relating to factors which are affecting the growth of containerization and intermodal freight activities. The general areas of concern include (1) economic factors, such as operating costs, investments, and the rate determining matters, (2) the availability of container equipment, (3) labor problems, (4) the influence of government, and (5) affairs relating to coordination of intermodal movements. The intention has been to present the divergence of opinion in these areas which reflect the individual concerns of those engaged in the various activities which contribute to the total transport system.

The factors which have been reviewed in the literature were used as the basis for a questionnaire research tool. The next two chapters discuss the methodology employed in the use of the questionnaire and the evaluation of results obtained from the investigation of factors believed to be inhibiting growth of containerization in domestic surface freight shipments.

CHAPTER III--FOOTNOTES

[1]Maritime Cargo Transportation Conference, pp. 15-16.

[2]*Ibid.*, p. 27.

[3]Merrill J. Roberts, *Intermodal Freight Transportation Coordination: Problems and Potential* (Pittsburgh: University of Pittsburgh, 1966), pp. 393-395.

[4]U.S. Interstate Commerce Commission, *Cost of Transporting Freight by Class I and Class II Motor Common Carriers* (Washington, D.C.: Government Printing Office, 1968), p. 20.

[5]173 ICC 377, ICC Docket No. 21723, p. 398.

[6]For a recent cost analysis of transporting via piggyback, see Ann F. Friedlander, *The Dilemma of Freight Transport Regulation*, Appendix B "Derivation of the Costs of Transporting High-Value Goods" (Washington, D.C.: The Brookings Institution, 1969). If consideration is given to added inventory costs for longer time in transit, the line haul costs of boxcar operations were estimated as roughly equal to piggybacking line haul costs.

[7]Merrill J. Roberts, p. 82.

[8]*Ibid.*, p. 137.

[9]"'Super C,' Sante Fe Claims It Has World's Fastest Freight Train," *Railway Age*, January 29, 1968, p. 25.

[10]Alan R. Cripe, "Containerization and Integral Trains," in *Integral Trains* (Chicago: Railway Systems and Management Assn., 1963), pp. 17-18.

[11]Robert A. Hammond, "Emerging Changes in the Container Revolution," in *Highway Research Record--No. 281* (Washington, D.C.: Highway Research Board, National Research Council, 1969), p. 15.

[12]Marvin J. Barloon, "Containers--Economics and Impact," in Regular Common Carrier Conference Report on Containerization in International and Domestic Traffic (Washington, D.C.: American Trucking Assn., 1969), p. 4.

[13]John P. Doyle, p. 3.

[14]"1970 Outlook--Carmarket: 70,000 in '70," Railway Age, January 19, 1970, p. 38.

[15]Reynolds Metals Company, p. 38.

[16]United States Steel Company, p. 9.

[17]Gus Welty, "Special Piggyback Reports: TOFC/COFC," Railway Age, November 27, 1967, p. 36.

[18]Alan R. Cripe, p. 21.

[19]"Big 'Boxing' Event," Distribution Worldwide, April, 1970, p. 59.

[20]For a rather complete discussion of rate structures, see Dudley F. Pegrum, Transportation: Economics and Public Policy (Homewood, Illinois: Richard D. Irwin, 1963), pp. 174-186 and 228-230.

[21]"ICC Must Choose Between Marginal-Cost or Full-Cost Standard in Setting Rates," Traffic World, May 23, 1970, p. 68.

[22]"FMC Issues Rule Requiring Water Carriers to File Through, Joint Intermodal Rates," Traffic World, April 18, 1970, p. 79.

[23]"ICC Urges Enactment of Routes-Rates Measure as Senate Hearings Begin," Traffic World, May 9, 1970, p. 86.

[24]Josephine Ayre, p. 8.

[25]"The First Domestic Container Program," Handling and Shipping, July, 1970, p. 47.

[26]Josephine Ayre, p. 21.

[27]Ibid., p. 27.

[28]H. M. Werksman in a panel discussion, "Containerization--Problems of Today and Potential for Tomorrow" (Truck Trailer Manufacturers Assn., 26th Annual Convention, Grand Bahama Island, April 17, 1967), pp. 48-49.

[29]R. J. Owen, "Research and the Unit-Load Principle," in TOFC and Containerization (Chicago: Railway Systems and Management Assn., 1963), p. 51.

[30]"Market Boom in TOFC," Railway Age, August 26, 1963, p. 20.

[31]"Leased-Container Surge," Distribution Worldwide, April, 1970, p. 33.

[32]"1970 Outlook--Carmarket: 70,000 in '70," Railway Age, January 19, 1970, pp. 38, 92.

[33]"E. R. Birchler, "Containerization--The Inevitable" (speech before First Annual International Marketing Seminar, sponsored by Northeastern University at Sutton, Massachusetts, June 26, 1969), p. 8.

[34]Palmer Bayer, "Pool Systems and Coordination," in Coordinated Transportation, ed. by E. G. Plowman (Cambridge, Maryland: Cornell Maritime Press, 1969), pp. 195-200.

[35]W. E. Schirmer, "Integrated Physical Distribution--A Containerization Must," Brandon's Container World, May, 1970, p. 12.

[36]R. E. Howell, "Growth and Problems of Containerization," Distribution Worldwide, September, 1970, p. 40.

[37]Ibid., p. 38.

[38]XTRA Directory (Boston, Massachusetts: XTRA, Inc., 1970.

[39]"International Container Pool," Transportation and Distribution Management, January, 1969, p. 12.

[40]R. E. Howell, p. 40.

[41]T. F. Dillon, "Containerization--A New Twist on an Old Idea," Purchasing, January 28, 1962, p. 86.

[42]Regular Common Carrier Conference Report, p. 26.

[43]Fred Muller, Jr., "The Role of Standards in International Coordination," pp. 216-222, and John B. Hulse, "Standards and Specifications in Coordination," pp. 222-227, both in Coordinated Transportation.

[44]See Chapter II, "Containers and Handling Equipment," p. 55.

[45] Jane's Freight Containers, pp. 478-493.

[46] Guide for the Certification of Cargo Containers (New York: American Bureau of Shipping, 1969).

[47] Fred Muller, Jr., "The Impact of Container Standards on Integrated Transportation," in Papers--Eighth Annual Meeting--Transportation Research Forum (Oxford, Indiana: Richard B. Cross Co., 1967), p. 34.

[48] See Table 16, "Container Length--Selected Area Usage and 1968 Production," p. 54.

[49] Regular Common Carrier Conference Report, p. 28.

[50] John P. Doyle, National Transportation Policy, p. 666.

[51] T. F. Dillon, p. 86.

[52] ICC Commissioner L. K. Walrath (remarks before the National Conference of State Transportation Specialists, Seattle, Washington, May 8, 1968), p. 5.

[53] U.S. Department of Commerce, Maritime Administration, Automatic Container Identification Conference (Washington, D.C.: Government Printing Office, January, 1970).

[54] H. M. Werksman, p. 13.

[55] "The Container and the User," Mechanical Handling, October, 1969, p. 109.

[56] O. I. M. Porton, "A Look at Labor and Containers in Europe" (talk before the Fifth International Container Exposition, Chicago, April 17, 1970), p. 1.

[57] Merrill J. Roberts, pp. 266-267.

[58] Ibid., p. 275.

[59] Ibid., p. 278, quoting from Article 29, Section 2, p. 42, National Master Freight Agreement, 1964.

[60] Ibid., p. 280.

[61] "Will Labor Help the Railroads Carry the Freight?" Editorial in Railway Age, March 4, 1968, p. 40.

[62]Seminars on the Container Revolution--November 13, 1967, prepared for use of the Committee on Commerce, U.S. Senate (Washington, D.C.: Government Printing Office, 1968), pp. 85-105.

[63]Ibid., p. 99.

[64]H. Bridges, "Containers and Their Effect on Waterfront Workers" (talk presented before the Fall Meeting of the Containerization Institute, Los Angeles, California, November 13, 1969), p. 3.

[65]H. F. Hammond, "Containerization--The Labor-Management Viewpoint" (talk presented before the Fall Meeting of the Containerization Institute, Los Angeles, California, November 13, 1969), pp. 5-6.

[66]R. F. Church, Background Note on the Development of Containerized International Shipping (Evanston, Illinois: The Transportation Center at Northwestern University, 1968), p. 24.

[67]T. W. Gleason, Address before the Fifth International Container Exposition, Chicago, April, 1970.

[68]"New York Port Balks," Distribution Worldwide, February, 1970, p. 14.

[69]"Another Round of ILA vs NYSA," Brandon's Container World, May, 1970, p. 4.

[70]Most comprehensive texts relating to Physical Distribution study offer extensive coverage of regulatory authority and activities of the governmental agencies. For example, see C. A. Taff, Chapter 16, "Regulation and Regulatory Procedure," in Management of Traffic and Physical Distribution (Homewood, Illinois: Richard D. Irwin, 1964), pp. 388-421.

[71]For a condensed presentation of the National Transportation Policy, see Interstate Commerce Commission--In the Public Interest (Washington, D.C.: Government Printing Office, 1970), p. 2.

[72]John P. Doyle, National Transportation Policy, p. 106.

[73]United States Department of Transportation (Washington, D.C.: Government Printing Office, 1969), p. 1.

[74]173 ICC 377, ICC Docket No. 21723, p. 450.

March
Servic
Washi
p. 30

Ocean

Manag

and P

Gover
by t
repo
Salz
View
1970

Asso
June

Man

Tra
Mar

[75]John P. Doyle, p. 654.

[76]U.S. Interstate Commerce Commission, 216 ICC 435, June 20, 1936, Trucks on Flatcars Between Chicago and Twin Cities, ICC Reports, Vol. 216 (Washington, D.C.: Government Printing Office, 1936), p. 435.

[77]U.S. Interstate Commerce Commission, 232 ICC 683, July 25, 1939, ICC Decision: Ex Parte No. 129, Substituted Freight Service, ICC Reports, Vol. 232 (Washington, D.C.: Government Printing Office, 1939), p. 683.

[78]293 ICC 93, ICC Docket No. 31375.

[79]U.S. Interstate Commerce Commission, 322 ICC 301, March 16, 1964, ICC Decision: Ex Parte No. 230, Substituted Service-Charges and Practices of For-Hire Carriers and Freight Forwarders (Piggyback Service), ICC Reports, Vol. 322 (Washington, D.C.: Government Printing Office, 1964), p. 301.

[80]See Table 8, "Piggyback Plans," p. 35.

[81]James E. Mazure, "Reducing Overlap Barriers in Ocean Commerce," in Coordinated Transportation, p. 103.

[82]Ibid., p. 104.

[83]"Joint Rates," Transportation and Distribution Management, June, 1970, p. 19.

[84]R. J. Blackwell, "Perspectives on Through Route and Rates," Brandon's Container World, May, 1970, pp. 27-28.

[85]A seminar titled, "Intermodal Transportation--Government Regulatory Policy," was conducted in March, 1970 by the State University of New York Maritime College. A report on the divergent views presented is given by Carlo J. Salzano, "Government, Industry Spokesmen Express Divergent Views on Intermodal Transport," Traffic World, March 4, 1970, pp. 21-25.

[86]ICC Commissioner L. K. Walrath (remarks before the Association of Interstate Commerce Commission Practitioners, June 21, 1968, Minneapolis, Minnesota).

[87]"White House Cool on Agency Merger Plan," Traffic Management, September, 1970, p. 11.

[88]"Nadar Group Says ICC Fail Public, Urges Single Transportation Regulatory Agency," Wall Street Journal, March 17, 1970, p. 613.

[89]R. F. Stoessel, "Transport in the '70's: Revolution Ahead," reprint from Business Management, November, 1969.

[90]John P. Doyle, pp. 138-144.

[91]C. P. Dircx, "Inter- and Intramodal Coordination on the Missouri Pacific," in Coordinated Transportation, pp. 183-191.

[92]Ann F. Friedlaender, p. 156.

[93]Ibid., pp. 185-186.

[94]W. J. Stenason, "Multi-Modal Ownership in Transportation," in Papers--Eighth Annual Meeting--Transportation Research Forum (Oxford, Indiana: Richard B. Cross Co., 1967), p. 471.

[95]"Independent Ownership of Modes Found Not to Be Hindering Containerization," Traffic World, April 18, 1970, p. 27.

[96]Gus Welty, "Tomorrow's Railroads," Railway Age, August 25, 1969, p. 36.

[97]"Railroader-Turned-Trucker W. G. White Says: 'We Need a Meeting of Minds on Common Goals,'" Railway Age, June 2, 1969, p. 20.

[98]Ann F. Friedlaender, p. 92.

[99]A. E. Gibson, "Land Bridge--Fact or Fiction?" (remarks before National Railroad Piggyback Assn., Montreal, Canada, 1969).

[100]K. Marshall, "New Routes for World Trade?" Transportation and Distribution Mangement, October, 1969, pp. 63-64.

[101]"The Ultimate Unit Train?--Support for Land Bridge Grows," Distribution Manager, May, 1968, p. 46.

[102]Comments have been obtained from remarks by Arthur E. Bayliss, National Director of NCITD before various groups. For example, "International Documentation--Where Are We Now?" before the Tenth Annual Conference of the Containerization Institute, New York, January, 1970.

[103]See Table 6, p. 26.

[104] S. V. Timberlake and C. E. Henshall, "Insurance Yardsticks for Export Containers," Distribution Manager, June, 1968, pp. 53-58.

[105] For an overall treatment of domestic transport claims practices, see C. A. Taff, Chapter 15, "Claims Procedure and Prevention," in Management of Traffic and Physical Distribution, pp. 358-387.

[106] Ann F. Friedlaender, p. 185.

[107] U.S. Interstate Commerce Commission, Transport Statistics of the United States, 1966; Part 8: Freight Forwarders (Washington, D.C.: Government Printing Office, 1967), p. 1.

[108] 82nd Annual Report of the Interstate Commerce Commission--Fiscal Year Ended June 30, 1968 (Washington, D.C.: Government Printing Office, 1968), p. 114. See also, "Hearing Opened by House Panel on Bill to Permit Rail-Forwarding Rate Making," Traffic World, January 31, 1970, pp. 17-21.

[109] "Inter-Freight--The Only System that Assumes Total Liability" (advertisement in the Wall Street Journal, July 7, 1970), p. 11.

[110] M. L. Fair, Coordinated Transportation, p. 303.

CHAPTER IV

FIELD RESEARCH METHODOLOGY

Factors Affecting Containerization Growth

A program may be developed to promote more effective use of containers if the factors which are inhibiting their use can be determined and arranged in an ordered sequence of relative importance. The problem faced in developing such an ordered listing is that opinion varies, depending upon the needs of the respondent in terms of freight activity. However, it may be possible to correlate the opinion of representatives of the individual sectors and thereby cater to their collective needs. The research undertaken in this project was designed to identify individual sector opinion as well as to develop an overall evaluation concerning problems of domestic freight containerization.

An analysis of the literature review presented in the previous chapters offers the conclusion that the major areas of concern may be categorized as follows: (a) economic factors, (b) equipment availability, (c) governmental regulation, (d) labor, and (e) coordinative activities. The research develops a body of opinion relating to containerization in each of these areas.

The general outline of research described in this chapter includes, (a) development of the hypotheses, (b) determination of the sample makeup, (c) design of a questionnaire, and (d) administration of the questionnaire. Testing of the hypotheses on the basis of the questionnaire replies is described in Chapter V.

Development of Hypotheses

General Considerations

A statistical hypothesis is a prediction of how the statistical analysis of quantitative data obtained from the research will evolve. In this investigation the hypotheses are stated in the null form and are subjected to statistical testing. The null hypothesis, H_o, assumes that there is "no significant difference" between two variables and that any differences noted are ascribed to chance error. The alternate hypothesis, H_1, may be accepted if statistical testing leads to rejection of H_o. The relationships are normally stated in algebraic form as follows:

Null Hypothesis	$H_o : A = B$
Alternate Hypothesis	$H_1 : A \neq B.$

Population Sectors and Proposed Statistical Hypotheses

Preliminary research and the literature review indicate that the population of those engaged in domestic freight activity which could dictate involvement in the use of containers can be roughly divided into three sectors. These sectors are (1) those who use freight services, (2) those who provide freight services, and (3) those who supply the equipment.

In this investigation, representatives of the respective population sectors were presented with a list of factors which are claimed to be retarding growth of containerization. Based upon the consensus of opinion, their collective evaluations were measured in terms of an overall ranking from the most important to the least important factor. Opportunities for statistical measurement are available in at least two areas which are, (1) agreement on the relative ranking of factors according to importance, and (2) agreement on the relative importance of each factor, considered individually.

On the basis of the above concepts, the following hypotheses are proposed and are offered in the null form for convenience in statistical testing:

<u>Hypothesis 1-A</u> (H_o): Factors inhibiting growth of domestic surface freight containerization are ranked in similar order, based upon collective evaluations of representatives of the following sectors: (1) potential

or actual users, (2) carriers, or (3) containerization equipment suppliers.

<u>Hypothesis 1-B</u> (H_o): Comparing evaluations of any one given factor said to be inhibiting growth of domestic surface freight containerization, there are no statistically significant differences in the level of importance as seen by representatives of the following sectors: (1) potential or actual users, (2) carriers, or (3) containerization equipment suppliers.

For purposes of illustration the alternate hypotheses will be presented for the two null hypotheses given. However, in order to simplify the reading, the alternate hypotheses will not be listed along with the remaining hypotheses to be presented. An alternate hypothesis is <u>implied</u> in each case.

<u>Alternate Hypothesis 1-A</u> (H_1): Factors inhibiting growth of domestic surface freight containerization are not ranked in similar order, based upon collective evaluations of representatives of the following sectors: (1) potential or actual users, (2) carriers, or (3) containerization equipment suppliers.

<u>Alternate Hypothesis 1-B</u> (H_1): Comparing evaluations of any one given factor said to be inhibiting growth of domestic surface freight containerization, there are statistically significant differences in the level of importance as seen by representatives of the

following sectors: (1) potential or actual users, (2) carriers, or (3) containerization equipment suppliers.

When considered in the light of types of goods or services offered, the Freight User sector is composed of a wide variety of firms. Business differences may influence attitudes toward containerization. The needs of the study should be met if this variety of attitude is identified in terms of broad categories which cover most of the sector. Accordingly, the following hypotheses are proposed:

Hypothesis 2-A (H_o): Factors inhibiting growth of domestic surface freight containerization are ranked in similar order, based upon collective evaluations of representatives of the following sectors of the freight user population: (1) durable goods manufacturers, (2) nondurable goods manufacturers, (3) retailers, and (4) freight forwarders.

Hypothesis 2-B (H_o): Comparing evaluations of any one given factor said to be inhibiting growth of domestic surface freight containerization, there are no statistically significant differences in the level of importance as seen by representatives of the following sectors of the freight user population: (1) durable goods manufacturers, (2) nondurable goods manufacturers, (3) retailers, and (4) freight forwarders.

Relative size of the Freight User firms may be an important factor in influencing their attitudes toward containerization. The larger firms can be expected to have

a greater command of capital required to modify existing practices. The breadth of territory covered and the average size of shipments are examples of important variables related to firm size. In this connection, the following hypotheses are offered:

<u>Hypothesis 3-A</u> (H_o): Factors inhibiting growth of domestic surface freight containerization are ranked in similar order, based upon collective evaluations of representatives of larger and smaller firms in the freight user population.

<u>Hypothesis 3-B</u> (H_o): Comparing evaluations of any one given factor said to be inhibiting growth of domestic surface freight containerization, there are no statistically significant differences in the level of importance as seen by representatives of larger and smaller firms in the freight user population.

The type of freight activity engaged in by the firms in the User section can also be categorized. For example, a retail business is likely to be engaged primarily in receiving freight. A manufacturer may receive raw materials and ship finished products. A raw material supplier may act primarily as a shipper. The freight forwarder is seen as a carrier when soliciting business, but as a shipper in the eyes of the operating carriers. These differences in freight activity may influence attitudes toward containerization. Therefore, the following hypotheses are offered:

<u>Hypothesis 4-A</u> (H_o): Factors inhibiting growth of domestic surface freight containerization are ranked in similar order, based upon collective evaluations of representatives of the freight user population participating in the following categories: (1) shippers, (2) consignees, (3) combined shipper and consignees, or (4) freight forwarders.

<u>Hypothesis 4-B</u> (H_o): Comparing evaluations of any one given factor said to be inhibiting growth of domestic surface freight containerization, there are no statistically significant differences in the level of importance as seen by representatives of the freight user population participating in the following categories: (1) shippers, (2) consignees, (3) combined shipper and consignees, or (4) freight forwarders.

The literature review revealed that containerized domestic surface freight shipments are largely handled by the motor and rail carriers. However, the air and marine modes are in contact with domestic movements at their respective interfaces and, accordingly, can influence development of container usage. The next hypotheses are submitted in recognition of the different needs and attitudes of the modal representatives of the Carrier sector.

<u>Hypothesis 5-A</u> (H_o): Factors inhibiting growth of domestic surface freight containerization are ranked in similar order, based upon collective evaluations of

representatives of the freight carrier population in the following segments: (1) motor, (2) rail, (3) marine, (4) air, and (5) port authorities.

<u>Hypothesis 5-B</u> (H_o): Comparing evaluations of any one given factor said to be inhibiting growth of domestic surface freight containerization, there are no statistically significant differences in the level of importance as seen by representatives of the carrier population in the following segments: (1) motor, (2) rail, (3) marine, (4) air, and (5) port authorities.

Thus far the hypotheses have been concerned with the relative importance ascribed to the various factors which may be inhibiting growth of containerization, as seen by the various sectors involved in freight activities. Reflective consideration indicates that an examination of the actual containerization practices of Freight Users may develop relationships which would be enlightening to the study. Factors which could be influential in decisions to use containers in domestic freight include present use of them in foreign shipments, present use of TOFC piggyback, and present ownership of a substantial number of containers. These considerations lead to proposal of the following hypotheses:

<u>Hypothesis 6</u> (H_o): The use of containerization by firms in domestic shipments is statistically independent of their use of containerization in foreign shipments.

<u>Hypothesis 7</u> (H_o): The use of containerization by firms in domestic shipments is statistically independent of their use of TOFC (Trailer on Flatcar) piggyback.

<u>Hypothesis 8</u> (H_o): The practice of containerization by firms in either domestic or foreign shipments is statistically independent of their ownership of containers.

<u>Hypothesis 9</u> (H_o): The use of containers by Freight Users in either domestic or foreign service is statistically independent of the type of business in which they are engaged.

<u>Hypothesis 10</u> (H_o): The use of containers by Freight Users in either domestic or foreign service is statistically independent of the relative sizes of the businesses.

<u>Hypothesis 11</u> (H_o): The use of containers in either domestic or foreign service is statistically independent of the type of Freight User activity (shipper, consignee, shipper and consignee, or forwarder).

The next section will discuss the requirements of the sample which is used to test the hypotheses.

The P

it se

sect

conc

deve

samp

Determination of the Sample

The Population Sectors

A primary requirement of the sample design is that it meets the needs of the hypothesis tests. In the previous section the various strata of the population which are of concern in this study were identified as the hypotheses were developed. The sectors which must be represented in the sample are related to the hypotheses as follows:

Hypothesis 1: Freight Users, Carriers, and Containerization Equipment Suppliers.

Hypothesis 2: Durable goods manufacturers, non-durable goods manufacturers, retailers, and freight forwarders among the Freight User sector.

Hypothesis 3: At least two levels of relative size among the Freight User sector.

Hypothesis 4: Shippers, consignees, combined shippers and consignees, and freight forwarders. This classification can be seen to overlap the requirements of Hypothesis 2, with freight forwarders being the most obvious example.

Hypothesis 5: Motor, rail, marine, and air carriers and port authority segments of the Carrier sector.

Hypotheses 6 through 11: The Freight User sub-sectors.

If the business size requirement is limited to two levels, the sample strata separations of the Freight User sector can be illustrated in the diagram shown below:

	Durable Goods Manufacturer	Nondurable Goods Manufacturer	Retailer	Forwarder
Larger	X	X	X	X
Smaller	X	X	X	X

Statistical Considerations of Sample Size

With random sampling the larger the sample, the closer the "true" value of the population statistic is approached.[1] The problem then becomes one of balancing the cost of collecting a large sample against the risk of not obtaining a "true" value of the population being sought. Methods available for calculating sample size are concerned with the standard error of the mean and are valid for parametric statistics. Since the questionnaire in this study employs an ordinal scale of estimated "levels of importance," nonparametric methods of analysis are indicated.[2] A "rule of thumb" that a random sample of 30 will ordinarily produce a mean value acceptably close to the true mean of the population is a useful approximation for use with nonparametric statistics.[3]

The chi-square distribution is useful in dealing with nonparametric statistics and it is employed in this

study. A "rule of thumb" relating to sample size for chi-square analysis is quoted from Chao as follows:[4]

> The larger the sample size, the better the approximation will be. In the test of goodness of fit, the expected frequency of each class must be at least 5 in order to have a good fit. Similarly, in a test of independence the expected frequency should also be 5 or more when the degrees of freedom are larger than 1. When the degrees of freedom are exactly 1, or when a 2 x 2 contingency table is used, the sample size should be large enough so that no expected frequency is smaller than 10. (Emphasis added.)

The "rule of thumb" for a random sample of 30 and Chao's estimates of minimum sample size for chi-square analysis were used in determining the sample size for the questionnaire mailing.

The Sample Schedule

Calculations of the required sample size were based upon a conservative one-third return of the questionnaire mailing. At least 30 replies were desired from each of the three major population segments of (1) Freight Users, (2) Carriers, and (3) Container Equipment Suppliers. An additional requirement was a minimum of 10 replies for each subsector of the User and Carrier strata. The sample as originally intended is presented in Table 24. This was subsequently modified in cases where the total population of a subsector is less than the original number desired. (For example, there are not 30 major air carriers available, to provide a one-third return = 10 replies.)

Table 24. Questionnaire sample schedule

Sector	Intended Sample	Expected Return	Actual Sample	Actual Return
FREIGHT USERS:				
(Large)				
Durable goods mfgr.	30	10	31	29[a]
Nondur. goods mfgr.	30	10	31	18
Retailer	30	10	28	21
Forwarder	30	10	16	12
(Small)				
Durable goods mfgr.	30	10	33	22
Nondur. goods mfgr.	30	10	27	18
Retailer	30	10	32	12
Forwarder	30	10	42	15
Freight User subtotal	240	80	240	147
CARRIERS:				
Motor	30	10	40	33
Rail	30	10	24	21
Air	30	10	17	14
Marine	30	10	17	15
Port authorities	30	10	21	13
Carrier subtotal	150	50	119	96
EQUIPMENT SUPPLIER	90	30	104	55[a]
Grand totals	480	160	463	298

[a]Some of the "Equipment Suppliers" identified themselves as "Durable Goods Manufacturers" in the replies, which accounts for the unusually high return in the latter category.

Examination of the actual returns listed in Table 24 reveals that the major sampling objectives were met, namely, (1) at least 30 sampling units are in each major subgroup, (2) at least 10 units are available for every cell, and (3) when size separations are combined, each minor group of the Freight Users strata totals close to 30 or more. Returns of from 60 to 87 percent were realized where the total population size of a subgroup is a limiting factor. These numbers indicate that with random sampling the mean values determined should approximate "true" values.

Establishment of the Working Sample

Only the larger firms in the Freight User category were considered sufficiently involved in containerization practices that their opinions would be meaningful. Names of these firms found in the *Fortune 500* listing[5] and the *Fortune Second 500* listing[6] were used as a sampling frame. (A "frame" is a means of access to a portion or all of a universe.)

A decision was made with respect to designation of "larger" and "smaller" firms in the segmentation on the basis of size. A separation at "over $200 million" annual sales includes the top 428 industrial firms and the top 50 retailers in the *Fortune 500* listing. The remainder of firms in the top 500 list and the *Fortune Second 500* list are included in a cutoff point of $50 million annual sales.

A Dun and Bradstreet listing of annual sales for 48 freight forwarders indicates $1 million annual sales as an acceptable separating point between large and small firms.[7] Therefore, the Freight User subsectors were designated as "larger" and "smaller" firms according to the following schedule of annual gross sales:

	Larger	Smaller
Manufacturers (durable and nondurable)	Over $200 million	$50 to $200 million
Retailers	Over $200 million	$50 to $200 million
Forwarders	$1 million and over	Less than $1 million

All of the Dun and Bradstreet forwarder names were used and these were supplemented with an additional listing in the "1970 Routing and Transportation Information Directory."[8]

A table of random numbers was used to pick the sample units from the _Fortune_ listings of manufacturing and retailing firms.[9] The retailer list was supplemented by random picks from _Moody's Industrial Manual_.[10]

All of the "Transportation Companies" in the _Fortune_ listing that meet the carrier sample requirements were used. These units were supplemented by listings in _Moody's Transportation_[11] so that essentially a complete sample of the major carrier firms was used. The sample of Port Authorities was obtained from _The American Association of Port_

Authorities--1970 Handbook and includes all the major ports on the Atlantic, Pacific, Gulf, and Great Lakes.[12]

The Container Equipment Supplier sample includes manufacturers of containers, leasors of containers, and others associated with the industry, such as manufacturers of container fittings and container handling equipment. Names were obtained from Jane's Freight Containers,[13] the above-listed sources, and advertisements in transportation magazines. With a sample objective of at least 100 sample units it was necessary to use all names meeting the strata requirements.

Development of the Questionnaire

General Considerations

From the analysis thus far certain points have been developed which indicate the use of a mail survey as the best means of determining the factors which are inhibiting the growth of containerization in domestic freight shipments. Predominant among these are the following considerations:

1. The range of factors offered in the literature indicates the need for a questionnaire covering a number of areas related to the problem.
2. The diverse backgrounds of those involved in containerization dictates a sample with representation from the many subsectors of the population. The desired sample is large (over 400) and it is also spread over the entire United States.

The mail survey is a commonly used research tool, and much information has been written on the practice.[14] Among advantages of mail surveys in comparison to other methods of data collection are:

1. Wider distribution
2. Less bias in sample distribution
3. No interviewer bias
4. Better chance for truthful reply
5. Better chance of thoughtful reply
6. Time and cost saving
7. Centralized control.

The main considerations in questionnaire construction as offered by Erdos which apply to this study are:[15]

1. The questionnaire should contain all the important questions on the subject, but none which are not purposeful
2. It should appear brief and easy to complete
3. The reader must be made to feel that he is participating in an important and interesting project.

Design of the Questionnaire

In order to meet the needs of the study, the questionnaire had to be designed to provide the following:

1. A body of opinion concerning the relative importance of factors retarding containerization in domestic surface freight shipments. This information had to be in a form which could be analyzed and used for testing of the hypotheses proposed.
2. Ability to segregate the respondents into their representative population subsectors.
3. Information which could be used to develop an analysis of containerization practices of Freight Users.

The questions included in the final questionnaire represent the major areas of concern relating to containerization found in the literature. To meet the needs of brevity and clarity each factor was listed in title heading form and was followed by an abstract or quotation from the literature. The following listing is not in the order offered in the questionnaire, nor are the factors segregated according to major areas of concern.

1. Economic Factors

INVESTMENT REQUIREMENTS
Adoption of containerization requires a capital investment decision.

DISTRIBUTION OF BENEFITS
Benefits from containerization may not be distributed proportionately to respective participants' investments.

TERMINAL HOLDUPS
Rail or truck terminal holdups cause undesirable shipment delays.

TOFC ALTERNATIVE
TOFC (Trailer on Flatcar) piggyback service provides an acceptable alternative to containerized shipments.

EXISTING TOFC INVESTMENTS
Containerization may not offer sufficient economic incentive for switching to those who are heavily invested in TOFC piggyback facilities.

INADEQUATE RATE STRUCTURES
Through shipment rate structures are needed to encourage a shift to containerization.

EMPTY CONTAINER TRAFFIC AND TARIFFS
Unbalanced traffic and nonstandard empty container rates contribute to "dead head" movement costs.

INEFFICIENT CONTAINER CUBE vs VANS
Trailer vans offer more efficient cubic volume per trip in over-the-road trips than standard containers.

2. Equipment Availability

<u>NONSTANDARD CONTAINERS</u>
The existence of nonstandard containers inhibits intermodal transfers.

<u>CONTAINER AND CHASSIS SHORTAGES</u>
Shortages of containers or chassis/bogey rigs result in shipment delays.

3. Government Regulation

<u>LACK OF GOVERNMENT LEADERSHIP</u>
Government has supplied little leadership in promoting containerized intermodal traffic.

<u>GOVERNMENTAL REGULATION</u>
Governmental regulations and agency jurisdictional overlaps retard containerization developments.

<u>INTERMODAL OWNERSHIP FORBIDDEN</u>
Present laws and regulations prevent common ownership or control of modes.

4. Labor

<u>LABOR RESISTANCE</u>
Threat of loss of jobs encourages the labor movement to impede containerization.

5. Coordinative Activities

<u>DIVIDED CARRIER RESPONSIBILITY</u>
Responsibility for coordination of intermodal freight movements is divided among the carriers involved.

<u>LACK OF LAND BRIDGE</u>
An effective coast-to-coast rail container land bridge has not yet been developed.

<u>INADEQUATE CONTAINER INTERCHANGE</u>
An effective national container pool system does not exist.

<u>LACK OF MOTOR CARRIER SUPPORT</u>
Many truckers believe that expanded containerization would reduce less-than-truckload and long haul revenues.

<u>SHIPLINE LEADERSHIP</u>
Shiplines have taken major responsibility for promoting containerization without giving adequate consideration to domestic sector needs.

<u>INTERMODAL RIVALRY</u>
No carrier sells intermodal operations; each one tries to sell his own mode.

An open-ended question was included to cover two situations which are (1) certain factors important in inhibiting containerization might not have been discovered in the literature, and (2) inclusion of every minor conceivable point would make the questionnaire excessively long. The open-ended question was presented on a separate page to allow adequate room for comment and was phrased as follows:

> If there are any factors which have not been covered in the questionnaire which you feel are important in inhibiting growth of containerization in domestic surface movements, or if you have any additional comments to offer, please note them on the remainder of this sheet.

The respondent was asked to indicate his estimate of the level of importance of each factor on a multiple choice scale which will be discussed more fully at a later point in this chapter.

In order to segregate respondents into their representative population subsectors, they were directed to the following:

> Check below which category most closely represents your firm's viewpoint in answering a freight questionnaire.
>
> USER: Shipper_____ Consignee_____ Forwarder_____

CARRIER: Motor_____ Rail_____ Marine_____
Air_____

CONTAINER EQUIPMENT SUPPLIER_____
OTHER--Specify_______________

The Freight Users were separated by firm size through response to the most appropriate annual gross sales bracket from among the following: (1) Over $200 million, (2) $50 to $200 million, (3) $10 to $49 million, (4) $1 to $9 million, and (5) Less than $1 million.

Separation according to the Freight User firm business activity was obtained from the following classifying question:

DURABLE GOODS MANUFACTURE_____(Machinery, transport equipment, primary metals, wood, furniture, glass, fabricated products, etc.)

NONDURABLE GOODS MANUFACTURE_____(Food, beverage, tobacco, drugs, textiles, apparel, paper, publishing, chemicals, petroleum, etc.)

RETAILER_____ OTHER--Specify_________________

Information which could be used to develop an analysis of containerization practices among Freight Users was obtained by "yes" or "no" answers to the following five questions:

1. Does your firm ship or receive trailer-on-flatcar (TOFC piggyback) freight in domestic trade?

2. Does your firm ship or receive containerized freight in domestic trade?

3. Does your firm ship or receive containerized freight in foreign trade?

4. If your firm <u>does</u> ship or receive <u>containerized</u> freight, do you <u>own</u> most or all of the containers you use?

5. Regardless of your freight practices, are some of your goods deemed containerizable?

An earlier form of the questionnaire which contained 23 factors was submitted to 31 physical distribution specialists who were participating in a seminar. On the basis of their comments the factors were reduced to 20 and wordings were changed to improve clarity. In addition, the form had requested the respondent to identify himself and his firm. Because of comments that this would tend to inhibit participation, the final version provided for voluntary identification.

Respondents were asked to fill in their name on a separate piece of paper in order to obtain a summary of the study. Erdos states that the use of an appropriate incentive will usually increase the response rate and, thereby, make the results of the survey more reliable.[16] A total of 181, or 61 percent, of those who completed the questionnaire requested a summary of the results.

The Rating Scale

With the containerization inhibiting factors defined, the problem becomes one of providing a means for each respondent to indicate the respective levels of importance. The evaluations must be available in a form which can be processed for use in testing the hypotheses. For example, if the respondent were merely asked to write his opinion on each factor the result would be a wide range of divergent answers which would have to be categorized into somewhat homogenous groups. Statistical analysis would be difficult. For these reasons a numerical rating scale was used as a factor evaluation tool. A rating scale has been defined as "a psychological measuring instrument that requires the rater or observer to assign the rated object to categories or continua that have numerals assigned to them."[17] Guilford comments that numerical rating scales are among the easiest to construct and apply, and are the simplest in terms of handling the results. They can be used directly in statistical analysis.[18]

The work of Osgood et al. on the fundamentals of semantics offers valuable guidance in the development of a rating scale.[19] In discussing semantic space, they state,

> The point in [semantic] space which serves as an operational definition of meaning has two essential properties--direction from the origin, and distance from the origin. We may identify these properties with the quality and intensity of meaning, respectively.

Through factor analysis they determined that the factors of evaluation, potency, and activity account for most of the semantic analyses made.[20] Important-unimportant is an evaluative factor and is the one chosen for the rating scale in this study. The potency factor is concerned with power, such as size, weight, and toughness. The activity factor is concerned with such things as quickness,

excitement, and agitation. Factors described in the literature on progress of containerization appear to be involved almost entirely with the evaluative factor. Accordingly, the rating scales were limited to the important-unimportant evaluative factor.

In a one-way scale the opinion or stimulus being evaluated begins at or near zero and increases in intensity; application of an electric shock at varying levels is an example which illustrates a one-way stimulus vector. In this study a one-way scale starting from essentially no importance up to extreme importance is indicated for the inhibiting influence of the various factors on containerization development.

Osgood arrived at an optimum seven "equally-spaced" steps along a two-way vector in developing scales. With a greater number it became difficult to discriminate and with fewer than seven steps observers complained of inadequate differentiation.[21] With the one-way semantic vector indicated for this study, a five step separation was chosen with medium importance used for the mid-point of intensity. Reinforcing instructions were used to fix in the mind of the observer the intent of the evaluation. The scale was presented in the questionnaire as follows (one of the questions is included for clarity):

Please indicate your estimate of the relative importance of each FACTOR listed below in retarding growth of containerization in domestic surface shipments. . . . The degree of importance choice has been scaled as follows:

1. Extremely Important
2. Quite Important
3. Medium Importance
4. Not Very Important
5. Almost No Importance

Circle your choice 1 2 3 4 5

RELATIVE IMPORTANCE OF FACTORS RETARDING DOMESTIC SURFACE CONTAINERIZATION

1. NONSTANDARD CONTAINERS
   The existence of nonstandard containers inhibits intermodal transfers. 1 2 3 4 5

Mailing and Processing of the Questionnaire

A copy of the cover letter used in this study and a copy of the follow-up letter sent out two weeks later are found in Appendix A. A Directory of persons actively engaged in physical distribution executive work was used as a major source of addresses.[22] A stamped, self-addressed envelope and provisions for anonymity of respondents were provided.

The follow-up mailing was directed to all except those who could be identified as replying to the first mailing. Except for a revised letter, it contained the same material as the first mailing. To check for possible bias from the order in which the factors were listed in the questionnaire, the questions were printed in reverse order for

the second mailing (referred to in further discussion as Form I and Form II, respectively). A record of questionnaires returned in response to the first and second mailings was maintained. This record was included in the data processing cards for use in testing bias.

There were 194 replies received from the initial mailing (approximately 42 percent). This total was increased to 298 replies (over 64 percent) with the second mailing. Five additional questionnaires trickled in after the replies had been analyzed, with the last one arriving a full three months after the initial mailing!

The percentage breakdown of returns from the three major sample categories is presented in Table 25 which follows.

Table 25. Percentage returns from major sample sectors

	Sample Units	Returns Units	Returns (%)
Freight Users	240	147	61
Carriers	119	96	81
Equipment Suppliers	104	55	53
Overall	463	298	64

expe

resp

Good

nums

in t

Carr

of a

Pre

In

A k

ret

The Freight User category was inflated at the expense of the Equipment Supplier segment because the latter respondents sometimes categorized themselves as Durable Goods Manufacturers. Where such a respondent identified himself by name the questionnaire was corrected to place him in the original intended category. The high return of the Carrier segment indicates a higher interest in the problem of containerization development than that evidenced by Freight Users.

A card file was prepared to correspond to each firm in the sample and each card was provided with a key number. A keypunched card was prepared for each questionnaire returned. Coded into each card were the following items:

1. A three digit respondent number (a "900" series number was used to designate replies of unidentified respondents).

2. A single digit number indicating the respondent's business category.

3. A single digit number to indicate the respondent's freight activity, if the firm was classified as a Freight User.

4. The digit corresponding to the "Importance" scale choice for each of the 20 factors evaluated with respect to inhibiting influence on containerization development.

5. A digit corresponding to a "Yes," "No," or Blank choice, indicating replies to the five questions which were designed to relate containerization activities.

6. A digit corresponding to the annual gross income of Freight User firms.

7. A digit indicating whether the questionnaire was Form I (mailed before the follow-up letter), or Form II (mailed after the follow-up letter).

An open-ended question had requested respondents to comment on any factors which had not been covered in the questionnaire. Replies were consolidated where possible into related categories.

The Program for Statistical Testing of Hypotheses

The purpose of this section is to provide the reader with a general understanding of the reasoning employed and factors considered in development of the hypothesis testing program. It is considered beyond the needs of this paper to present more than the basic considerations and limitations of the statistical methods as they apply to this analysis. Where a formula is offered the complete development and in depth discussion concerning it can generally be found in the footnoted references.

The steps for testing a hypothesis have been listed as including the following:[23]

> <u>Step 1</u>: State a null hypothesis H_0 and an alternative hypothesis H_1. [For the sake of clarity, where a number of hypotheses are proposed, the alternative may be implied, but not spelled out.]
>
> <u>Step 2</u>: Decide on an appropriate sample statistic and test statistic. The choice of a test statistic is based on (1) the null hypothesis, H_0, (2) the sample statistic, and (3) assumptions concerning the sample population distribution.
>
> <u>Step 3</u>: Decide on a level of significance α and a sample size N.

> Step 4: Obtain a sample statistic and compute the test statistic. Accept or reject H_o in accordance with where the test statistic falls with respect to the region of rejection.

Taking into consideration the matters which have already been discussed, the following steps remain to be reviewed:

1. Choice of appropriate sample statistics
2. Choice of appropriate test statistics
3. Decisions concerning the proper level of significance α.

Implied in the choice of appropriate test statistics for the respective hypotheses is the choice of statistical methods for deriving these test statistics.

Sample Statistic

Arithmetic mean is the measure of central tendency used as the sample statistic in the testing of Hypotheses 1 through 5. Use of the arithmetic mean assumes equal intervals in the numerical semantic differential scale employed in the questionnaire. Osgood *et al*. offer data to substantiate their position that scales employing the terms such as "extremely" and "quite" are associated with more or less equal interval degrees of intensity of whatever is being measured.[24] They use mean values for measures of central tendency in their calculations. It is recognized however, that the work deals with a "pseudo-interval" scale rather than an absolute interval scale and, as such, the mean

values are in error to the extent that the successive intervals on the scale are not equal. No assumptions are made concerning the form of the distributions in the populations and the "standard deviation" applied to "normal" distributions is not used.

For testing Hypotheses 6 through 11, a simple "Yes-No" scale is employed. Siegel agrees that such a dichotomy meets the requirement of continuum in an ordinal scale of ranking.[25] Such a requirement is necessary for the nonparametric techniques used in testing the proposed hypotheses. In this case, a sample frequency is used as the sample statistic.

Test Statistics for Hypotheses 1-A Through 5-A

A suitable statistic for testing of Hypotheses 1-A through 5-A is the Kendall coefficient of concordance, W.[26] It is a measure of the correlation among several rankings of N objects (or factors). The coefficient, W, can be tested against the chi-square distribution when N is larger than 7 by use of the following relationship:

$$x^2 = k\ (N-1)\ W$$

where x^2 = chi-square

k = the set of rankings

N = the number of factors being ranked, and

W = the Kendall coefficient, W.

te

thro

with

the

It

of

app

of

str

The

Wh

Th

The degrees of freedom = N - 1. In testing of Hypotheses 1-A through 5-A, N = 20, and the degrees of freedom = 19.

The chi-square distribution is useful in nonparametric analysis because it makes no assumptions concerning the distribution of the population from which it is drawn.[27] It has the important property that its shape approaches that of the normal distribution as the degrees of freedom approach 30 in number.

The coefficient, W, is based upon the sum of squares of differences from the means of the ratings and is demonstrated in an example below which shows a high concordance. The expression for the Kendall coefficient is:

$$W = \frac{S}{\frac{1}{12} k^2 (N^3 - N)}$$

where S = the sum of squares of differences from the mean,

k = the sets of rankings, and

N = the number of factors being ranked.

The following example of a high concordance is offered:

Ranks assigned to 5 factors by 3 groups

Groups (k)	Factors (N) 1	2	3	4	5
A	1	2	3	4	5
B	1	3	2	4	5
C	2	1	3	5	4
Sum of ranks = R_j	4	6	8	13	14
Mean of R_j's ($\Sigma R_j/N$)				45/5 = 9	
Deviation from Mean ($R_j - \Sigma R_j/N$)	-5	-3	-1	4	5
Deviations Squared $(R_j - \Sigma R_j/N)^2$	25	9	1	16	25
Sum of Squares = S			76		

$$W = \frac{S}{\frac{1}{12} k^2 (N^3 - N)} = \frac{76}{\frac{1}{12} \times 9 \ (125 - 5)} \ ; \ W = 0.845$$

W = 0.845 expresses the degree of agreement among the three groups in ranking the five factors. For perfect agreement, W = 1.00. The significance of any observed value of W may be tested by determining the probability associated with the occurrence under H_o of a value as large as the S with which it is associated. A table of critical values of S is offered in Siegel as Table R.[28] Reference to Table R reveals that the S = 76 associated with an agreement W = 0.845 is significant at a 1 percent confidence level. Thus, the null hypothesis that the observers in the example rank the samples similarly can be accepted with a 99 percent certainty that the indicated agreement is not caused by chance.

Test Statistics for Hypotheses 6 Through 11

The chi-square distribution is used in tests of independence of classification for Hypotheses 6 through 11. Values from the questionnaire replies were assembled for cross classification of data in contingency tables. The expression for the chi-square reference distribution is,

$$x^2 = \Sigma \frac{(f_o - f_e)^2}{f_e}$$

where f_o is an observed frequency, and

f_e is an expected theoretical frequency.[29]

The degrees of freedom is determined as

$$df = (r - 1)\ (c - 1)$$

where r = the number of rows in the contingency table and

c = the number of columns in the table.

For a 2 x 2 contingency table with 1 degree of freedom, the Yates correction for continuity is used to reduce the computed value of chi-square as follows:

$$x^2 = \Sigma \frac{(\,|f_o - f_e| - \tfrac{1}{2})^2}{f_e}$$

where $|f_o - f_e|$ is the absolute difference between f_o and f_e.

<u>Test Statistics for Hypotheses 1-B Through 5-B</u>

Testing of Hypotheses 1-B through 5-B is concerned with variances in mean values

a. determined on 20 factors, by

b. a large number of observers, which are drawn from

c. several populations sectors.

Multivariate analysis of variance is a logical technique if parametric methods can be justified.[30]

Variances are determined from sums of squares of deviations from group means. The relationship for the total variance is given by

$$V_t = V_b + V_w$$

where V_t = total variance,

V_b = between group variances, and

V_w = within group variances.[31]

A test involving these variances is the F ratio, where

$$F = \frac{V_b}{V_w} .$$

The F distribution approaches a normal distribution as the degrees of freedom of the sample groups increases.

Kerlinger points out that in the use of parametric statistics, two assumptions are made: (1) the samples have been drawn from populations which are normally distributed,

referred to as the assumption of normality, and (2) in analysis of variance, the variances within the groups are statistically the same, referred to as the homogeneity of variance. He goes on to state,

> The evidence to date is that the importance of normality and homogeneity is overrated. . . . Unless there is good evidence to believe that populations are rather seriously non-normal and that variances are heterogeneous, it is usually unwise to use a nonparametric statistical test in place of a parametric one. The reason for this is that parametric tests are almost always more powerful than nonparametric tests. [The power of a statistical test is the probability that the null hypothesis will be rejected when it is actually false.]

He further quotes other researchers as follows:

> . . . the *F* distribution is amazingly insensitive to the form of the distribution of criterion measures in the parent population. . . . In a large number of research situations the probability statements resulting from the use of *t* and *F* tests, even when these two assumptions are violated, will be highly accurate. . . . It is probably safer--and usually more effective--to use parametric tests rather than nonparametric tests.[32]

A third assumption concerning the use of parametric statistics is that the measures to be analyzed are continuous measures with equal intervals. It has been assumed from previous discussion that the intervals on the rating scales are sufficiently equal that the arithmetic manipulations required for *F* test are acceptable.

With the above mentioned justification for parametric testing in mind, Hypotheses 1-B through 5-B are tested by multivariate analysis of variance, employing an *F* test as the test statistic.

The Level of Statistical Significance α

In testing a hypothesis, the procedure is to reject H_o in favor of H_1 if a statistical test yields a value whose associated possibility of occurrence under H_o is equal to or less than some small probability symbolized as α (or p), called the level of statistical significance. In statistical decision theory, an α value of 0.05 or 0.01 is often used. In a normal distribution, these values correspond to $\pm$ two and three standard deviations, respectively, or 95 and 99 percent of the values included under the distribution curve.

In this study an $\alpha = 0.01$ is used in rejecting H_o when a nonparametric test is employed because such tests are generally less powerful than parametric tests. An $\alpha = 0.05$ is used in rejecting H_o when a parametric test is employed. In all cases the probability level associated with the findings are reported, indicating the level at which H_o may be rejected.

Summary of the Methodology

The methodology developed in this section is briefly recapitulated for the reader's benefit. A questionnaire consisting of four groups of questions is used as the research tool. The first group employs an equal appearing interval semantic differential scale for evaluation of the relative importance of factors reported to be retarding the growth of containerization in domestic surface freight shipments. The

second group of questions requires a "Yes-No" choice and is designed to determine the relationships of existing containerization practices. The third group establishes the sample sector of the respondent. The last item on the questionnaire is an open ended question concerning containerization retarding factors.

The populations sampled include Freight Users, Freight Carriers, and Containerization Equipment Suppliers. The first two groups have sample subsets. Samples were drawn randomly and of sufficient size to meet the requirements of the statistical tests employed.

Hypotheses 1-A through 5-A are concerned with the ranking of the factors according to importance from the first set of questions. Hypotheses 1-B through 5-B relate to differences in levels of importance assigned to any given factor from the first set of questions. Population segments are parallel in the two sets of hypotheses.

Hypotheses 1-A through 5-A are tested with the nonparametric Kendall coefficient of concordance, W, and a chi-square distribution. The level of α used in rejecting H_o is 0.01.

Hypotheses 1-B through 5-B are tested with the parametric multivariate analysis of variance related to an <u>F</u> distribution. The level of α employed is 0.05.

Hypotheses 6 through 11 are tested for independence of classification through the use of contingency tables and a chi-square distribution. For this nonparametric test an α value of 0.01 is used in rejecting H_o.

CHAPTER IV--FOOTNOTES

[1]F. N. Kerlinger, Foundations of Behavioral Research (New York: Holt, Rinehart and Winston, 1964), p. 160. For a simple development of the subject of sample size see C. T. Clark and L. L. Schkade, Chapter 9--"Sample Distribution and Estimation," Statistical Methods for Business Decisions (Cincinnati: South-Western Publishing Co., 1969).

[2]Sidney Siegel, Nonparametric Statistics for the Behavioral Sciences (New York: McGraw-Hill Book Co., 1956), p. 26.

[3]R. Ferber and P. J. Verdoorn, Research Methods in Economics and Business (New York: The Macmillan Co., 1962), p. 239.

[4]L. L. Chao, Statistics: Methods and Analyses (New York: McGraw-Hill Book Co., 1969), p. 292.

[5]"The Fortune Directory of the 500 Largest Corporations," Fortune, May 15, 1969, pp. 166-184.

[6]"The Fortune Directory of the Second 500 Largest Corporations," Fortune, June, 1970, pp. 98-125.

[7]Dun and Bradstreet, Reference Book of Transportation, Spring 1970 (Washington, D.C.: Trinc Transportation Consultants, 1970), p. 507.

[8]"1970 Routing and Transportation Information Directory," Handling and Shipping, February, 1970, pp. 41-49.

[9]Random numbers were obtained from "A Table of 14,000 Random Units," in S. M. Selby, ed., Standard Mathematical Tables (Cleveland: The Chemical Rubber Co., 1967), pp. 565-568. Numbers beginning on page 567 were used. The last three digits of five digit numbers determined picks from the two Fortune listings. Sample units were drawn until each subcategory had been filled.

[10]"Classification of Companies by Industries and Products," Moody's Industrial Manual--July, 1969 (New York: Moody's Investor's Service, Inc., 1969), pp. a172-a173.

[11] *Moody's Transportation*, March 27, 1970 (New York: Published semi-weekly by Moody's Investor's Service), pp. 1737-1747.

[12] *The American Association of Port Authorities, Inc.--Handbook 1970* (Washington, D.C.: AAPA, 1970), pp. 45-67.

[13] *Jane's Freight Containers*, pp. 449-476, 501-562.

[14] Paul L. Erdos, *Professional Mail Surveys* (New York: McGraw-Hill Book Co., 1970), p. 5. Additional material on mail surveys may be found in such writings as D. J. Luck, H. G. Wales, and D. A. Taylor, *Marketing Research* (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1970); also R. Ferber, D. F. Blankerts and S. Hollander, Jr., *Marketing Research* (New York: The Ronald Press, 1964).

[15] *Ibid.*, pp. 37-38.

[16] *Ibid.*, Chapter 11, "Incentives."

[17] F. N. Kerlinger, p. 514.

[18] J. P. Guilford, *Psychometric Methods* (New York: McGraw-Hill Book Co., 1954), Chapter 11, "Rating Scales," contains an extensive discussion on the subject.

[19] C. E. Osgood, G. J. Suci, and P. H. Tannenbaum, *The Measurement of Meaning* (Urbana, Illinois: University of Illinois Press, 1957), p. 26.

[20] *Ibid.*, p. 72.

[21] *Ibid.*, p. 85.

[22] *The Official Directory of Commercial Traffic Executives* (Washington, D.C.: The Traffic Service Corp., 1969).

[23] R. E. Kirk, *Experimental Design: Procedures for the Behavioral Sciences* (Belmont, California: Cole Publishing Co., 1968), p. 25.

[24] C. E. Osgood, p. 29 and p. 146.

[25] S. Siegel, p. 25.

[26] See S. Siegel, pp. 298-328 for the development of the Kendall coefficient of concordance, W.

[27]See C. T. Clark and L. L. Schkade, pp. 424-451 for a discussion of the chi-square distribution as applied to nonparametric statistics.

[28]S. Siegel, "Table R--Table of Critical Values of S in the Kendall Coefficient of Concordance," p. 286.

[29]C. T. Clark and L. L. Schkade, pp. 424 and 433.

[30]D. F. Morrison, Multivariate Statistical Methods (New York: McGraw-Hill Book Co., 1967). A comprehensive treatment of multivariate analysis. See especially, Chapter 5, "The Multivariate Analysis of Variance," pp. 159-198.

[31]F. N. Kerlinger, pp. 187-194.

[32]*Ibid.*, pp. 258-259.

CHAPTER V

RESULTS OF THE RESEARCH

Mechanics of the Hypotheses Tests

Keypunched cards were prepared in coded form to represent the information contained in each returned questionnaire as described earlier in the section, "Mailing and Processing of the Questionnaire." The cards were then used as data input with suitable available computer programs for testing the hypotheses. Facilities of the Michigan State University Computer Center were used for processing the programs. Both the Control Data Company CDC 3600 and CDC 6500 Computers were used.

The multivariate analysis of variance tests for Hypotheses 1-B through 5-B were performed through the use of Jeremy D. Finn's Multivariance Program, as supplied by the Office of Research Consultation in the College of Education at Michigan State University.[1] The program has many capabilities, but only those of direct concern to the study will be mentioned. An exact least squares method of analysis is employed. For tests of hypotheses, a stepwise univariate and multivariate multiple regression analysis is performed to determine the effects of the individual independent variables. Also, a univariate and step-down multiple correlation analysis is provided to determine the relationship between the independent variables and the individual dependent measures. The F-ratio for the multivariate test of equality of mean vectors is presented, as well as the level of statistical significance, α. The matrix of cell means related to the variables is also listed. Pertinent sections of the computer printout are found in Appendix B, Tables 41-49.

The tests of independence of classification for Hypotheses 6 through 11 were developed through the use of the NUCROS Program provided by the Computer Institute for Social Science Research (CISSR) at Michigan State University.[2] The program produces cross-classification or contingency tables in two, three, or four dimensions. Chi-square values and percentage tables (one by columns and one by rows) are produced. Relevant computer printout sections are found in Appendix B, Tables 50-56.

An operating version of a program for Kendall's coefficient of concordance, W, was not available for testing Hypotheses 1-A through 5-A. Mean values for the ranking of factors were obtained from the output of Finn's Multivariance Program. Group rankings were determined manually and Kendall's coefficient, W, was derived from the sum of squares, S, in the manner described earlier under the "Test Statistics" section. A sample calculation is presented in Table 28-C.

In testing Hypotheses 1-A through 5-A the value of chi-square is directly related to Kendall's W. Therefore, the null hypothesis of similar ranking is rejected when chi-square is less than the critical value. Hypotheses 6 through 11, concerning independence of the variables, are rejected when chi-square is larger than the critical value. The F value increases as the between group variances increase. Therefore, the null Hypotheses 1-B through 5-B are rejected when the F value is greater than the critical value.

Results of Tests of Hypotheses 1-A,B Through 5-A,B

Hypothesis 1-A and Hypothesis 1-B will be again proposed here for ready reference.

Hypothesis 1-A (H_o): Factors inhibiting growth of domestic surface freight containerization are ranked in similar order, based upon collective evaluations of representatives of the following sectors: (1) potential or actual users, (2) carriers, or (3) containerization equipment suppliers.

Hypothesis 1-B (H_o): Comparing evaluations of any one given factor said to be inhibiting growth of domestic surface freight containerization, there are no statistically significant differences in the level of importance as seen by representatives of the following sectors: (1) potential or actual users, (2) carriers, or (3) containerization equipment suppliers.

The same population subgroups are being considered in Hypotheses 1-A,B. Hypothesis 1-A concerns the differences in ranking of the list of factors according to the within group means. Rejection of the null hypothesis infers that the population subsectors rank the list of factors in significantly different order.

Hypothesis 1-B is subjected to a multivariate analysis of variance test which compares the importance levels assigned to each factor by the population subgroups. The mean value of all evaluations for a given factor by one of the population's subgroups represents the assigned level of importance. Evaluations are based on the rating scale (1 = Extremely Important, through 5 = Almost No Importance). Rejection of the null hypothesis infers that there are significant differences in the relative importance of given factors, as viewed by the population subsectors.

The same parallel structure applies to Hypotheses 2-A,B through 5-A,B, with different population subsector groupings being considered in each case. For this reason, results of tests for each null hypothesis pair (A,B) will be discussed jointly.

A summary of the tests of Hypotheses 1-A through 5-A is presented in Table 26. A summary of tests of Hypotheses 1-B through 5-B is presented in Table 27. Mean values used in all the tests are presented in the computer printout displays in Appendix B. The tables which summarize the

Table 26. Summary of tests of Hypotheses 1-A through 5-A[a]

H_o	Ranks Table	Means Table	Population Groups	Sum Squares	Kendall's W	Chi-Square	Decision	p
1-A	26-B	41	User Carrier Equipment Supplier	5063	0.845	48.3	Not reject H_o	0.01
2-A	29	43	User: Durable Mfg.--Large Nondur. Mfg.--Large Retailer--Large Forwarder--Large	8712	0.818	62.2	Not reject H_o	0.01
			User: Durable Mfg.--Small Nondur. Mfg.--Small Retailer--Small Forwarder--Small	6324	0.594	45.2	Not reject H_o	0.01
3-A	29	43	User: Durable Mfg.--Large Durable Mfg.--Small	2330	0.874	33.2	Reject H_o Not reject H_o	0.01 0.05
			User: Nondur. Mfg.--Large Nondur. Mfg.--Small	2105	0.792	30.1	Reject H_o	0.05
			User: Retailer--Large Retailer--Small	2012	0.755	28.6	Reject H_o	0.05
			User: Forwarder--Large Forwarder--Small	1859	0.700	26.6	Reject H_o	0.05
4-A	30	46	User: Shipper Consignee Shipper + Consignee Forwarder	8443	0.793	60.3	Not reject H_o	0.01
5-A	31	48	Carriers: Motor Rail Marine Air Port Authorities	8986	0.540	51.3	Not reject H_o	0.01

[a]S. Siegel, "Table C. Table of Critical Values of Chi-Square," p. 249. Degrees of freedom = (N-1) = (20-1); DF = 19. From Chi-Square Table: $x^2 = 30.1$ @ $p = 0.05$; $x^2 = 36.1$ @ $p = 0.01$.

Table 27. Summary of tests of Hypotheses 1-B through 5-B[a]

H_o	Means Table	Test Table	Population Groups	Tests F Ratio	Decision[b]	p
1-B	41	42	User	Multivariate		
			Carrier	$DF_1 = 40$ $DF_2 = 552$		
			Equipment Supplier	F - Ratio = 1.8094	Reject H_o	0.002
			Significant Factors	Univariate DF = 2		
			19. Inefficient Cube vs Vans	F - Ratio = 7.13		0.001
			10. TOFC Alternative	5.25		0.005
			5. Lack of Land Bridge	3.87		0.02
			8. Container Chassis & Shtg's	3.36		0.03
2-B	43	44	User: Durable Mfg.	Multivariate		
			Nondur. Mfg.	$DF_1 = 60$ $DF_2 = 358$		
			Retailer	F - Ratio = 1.1949	Not reject H_o	0.05
			Forwarder			
3-B	43	45	User: Durable Mfg.--Large vs Small	Multivariate		
			Nondur. Mfg.--Large vs Small	$DF_1 = 20$ $DF_2 = 120$		
			Retailer--Large vs Small	F - Ratio = 1.7094	Reject H_o	0.05
			Forwarder--Large vs Small			
			Significant Factors	Univariate DF = 1		
			16. Lack of Motor Carrier Support	F - Ratio = 4.97		0.02
			19. Inefficient Cube vs Vans	4.69		0.03
4-B	46	47	User: Shipper	Multivariate		
			Consignee			
			Shipper + Consignee	$DF_1 = 60$ $DF_2 = 370$	Not reject H_o	
			Forwarder	F - Ratio = 1.0133		0.05
5-B	48	49	Carriers: Motor	Multivariate		
			Rail			
			Marine	$DF_1 = 80$ $DF_2 = 286$		
			Air	F - Ratio = 2.0707	Reject H_o	0.0001
			Port Authorities			
			Significant Factors	Univariate DF = 4		
			1. Nonstandard Containers	F - Ratio = 7.16		0.0001
			10. TOFC Alternative	5.57		0.0005
			17. Shipline Leadership	5.47		0.0006
			19. Inefficient Cube vs. Vans	4.83		0.001
			7. Inadequate Container Interchange	4.53		0.002
			14. Inadequate Rate Structure	3.49		0.01
			11. Existing TOFC Investments	3.31		0.01
			13. Government Regulation	2.62		0.04

[a]For F-Ratio Table, see S. M. Selby, ed., Standard Mathematical Tables, "Percentage Points, F-Distribution" (Cleveland: The Chemical Rubber Co., 1967), pp. 556-562.

[b]Rejection = Significant Differences in Mean Values.

tests also indicate the appropriate mean value reference tables.

Hypotheses 1-A,B

Development of the test of Hypothesis 1-A is presented in three tables. Table 28-A lists the within group mean values for the 20 factors; Table 28-B rearranges the factors and ranks them within respective population sectors (lowest mean value is the most important factor; and Table 28-C presents a sample calculation of S (sum of squares), Kendall's W, and chi-square. The basis of the calculations was discussed in the section, "Test Statistics."

As indicated in Table 26, with a chi-square value of 48.3 derived from the comparative ranking of factors by the population subgroups, the null Hypothesis 1-A cannot be rejected at a confidence level p = 0.01. This infers that Freight Users, Freight Carriers, and Containerization Equipment Suppliers rank in similar order (based upon their collective evaluations) the 20 factors reported to be inhibiting growth of domestic surface containerization. Inspection of Table 28-B indicates the noticeable agreement on the factors, particularly at the top end and bottom end of the lists.

Results of the multivariate analysis of variance test summarized in Table 27 indicate that the null Hypothesis 1-B can be rejected at a confidence level p = 0.002.

Table 28-A. Within group mean values for test of Hypothesis 1-A[a]

Factors	Freight Users	Carriers	Equipment Suppliers
1. Nonstandard Containers	2.03	2.14	2.43
2. Investment Requirements	2.37	2.11	2.27
3. Distribution of Benefits	2.50	2.41	2.58
4. Divided Carrier Responsibility	2.36	2.22	2.40
5. Lack of Land Bridge	3.10	3.55	3.34
6. Intermodal Ownership Forbidden	2.60	2.79	2.76
7. Inadequate Container Interchange	2.09	2.22	2.38
8. Container Chassis & Shortages	2.26	2.62	2.63
9. Terminal Holdups	2.46	2.78	2.58
10. TOFC Alternative	2.28	2.76	2.69
11. Existing TOFC Investments	2.19	2.54	2.32
12. Lack of Government Leadership	3.04	3.02	2.98
13. Government Regulation	2.57	2.65	2.61
14. Inadequate Rate Structure	1.85	1.79	1.89
15. Empty Container Traffic	1.90	1.67	1.94
16. Lack of Motor Carrier Support	2.76	2.77	2.58
17. Shipline Leadership	2.43	2.27	2.38
18. Labor Resistance	1.85	2.09	2.12
19. Inefficient Cube vs. Vans	2.36	2.38	3.07
20. Intermodal Rivalry	2.30	2.46	2.45
Number in Sample	147	96	55

[a]Lowest Mean = 1 = Most Important Factor.

Table 28-B. Ranking of factors by within group means for test of Hypothesis 1-A[a]

Factors	Freight Users	Carriers	Equipment Suppliers
14. Inadequate Rate Structure	1	2	1
18. Labor Resistance	1	3	3
15. Empty Container Traffic	3	1	2
1. Nonstandard Containers	4	5	9
7. Inadequate Container Interchange	5	6	6
11. Existing TOFC Investments	6	12	5
8. Container Chassis and Shortages	7	13	15
10. TOFC Alternative	8	15	16
20. Intermodal Rivalry	9	11	10
19. Inefficient Cube vs. Vans	10	9	19
4. Divided Carrier Responsibility	10	6	8
2. Investment Requirements	12	4	4
17. Shipline Leadership	13	8	6
9. Terminal Holdups	14	17	11
3. Distribution of Benefits	15	10	11
13. Government Regulation	16	14	14
6. Intermodal Ownership Forbidden	17	18	17
16. Lack of Motor Carrier Support	18	16	11
12. Lack of Government Leadership	19	19	18
5. Lack of Land Bridge	20	20	20
Number in Sample	147	96	55

[a]Ranking: 1 = Most Important Factor.

Table 28-C. Calculation of Kendall's W for test of Hypothesis 1-A[a]

Group	Factors																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
User	4	12	15	10.5	20	17	5	7	14	8	6	19	16	1.5	3	18	13	1.5	10.5	9
Carrier	5	4	10	6.5	20	18	6.5	13	17	15	12	19	14	2	1	16	8	3	9	11
Equipment Suppliers	9	4	12	8	20	17	6.5	15	12	16	5	18	14	1	2	12	6.5	3	19	10
R_j	18	20	37	25	60	52	18	35	43	39	23	56	44	4.5	6	46	27.5	7.5	38.5	30
$\Sigma R_j/N$	630/20 = 31.5																			
$R_j - \frac{\Sigma R_j}{N}$	-13.5	-11.5	5.5	-6.5	28.5	20.5	-13.5	3.5	11.5	7.5	-8.5	24.5	12.5	-27.0	-25.5	14.5	4.0	-24.0	7.0	-1.5
$(R_j - \frac{\Sigma R_j}{N})^2$	182	132	30	42	812	420	182	12	132	56	72	602	156	729	651	210	16	576	49	2

$$\Sigma\left(R_j - \frac{\Sigma R_j}{N}\right)^2 = S = 5063. \qquad k = 3 \qquad N = 20$$

$$W = \frac{S}{\frac{1}{12} k^2 (N^3 - N)} = \frac{5063}{\frac{1}{12} \cdot 9\ (8{,}000 - 20)} \ ; \ W = 0.845$$

$$x^2 = k\ (N - 1)\ W = 3\ (20 - 1)\ 0.845 \ ; \ \text{Chi-square} = x^2 = 48.3$$

Cannot reject Hypothesis 1-A of similar order in rankings @ p = 0.01

[a]Ties are averaged.

The alternate hypothesis (H_1) states that there are differences in the relative importance of factors, as indicated by mean values, which are statistically significant. Univariate analysis indicates those factors whose means vary significantly and these will now be examined for possible insights concerning the evaluations.

Mean values of significant factors from Table 41 are presented below:

Significant Factor	User	Carrier	Supplier
19. Inefficient Cube vs. Vans	2.367	2.385	3.072
10. TOFC Alternative	2.285	2.760	2.690
5. Lack of Land Bridge	3.102	3.552	3.345
8. Container Chassis & Shortages	2.265	2.625	2.636

The following inferences can be drawn:

1. The Containerization Equipment Suppliers think the less efficient cube of containers (as opposed to vans for over-the-road movement) is not as important a factor in inhibiting containerization growth as do the Users and Carriers.
2. The availability of TOFC piggyback is more important as a deterrent to containerization growth in the opinion of Users than it is to the Carriers and Suppliers.
3. There is a spread in evaluation of the lack of a land bridge, with the Users thinking it comparatively most important of the three groups. It should be noted that all three groups ranked the lack of a land bridge as the least important of the 20 factors,

yet their differences as to the relative importance on the rating scale are statistically significant. This dichotomy illustrates the point of difference in analysis between Hypothesis 1-A and Hypothesis 1-B.

4. The contention that shortages of containers or chassis/bogey rigs result in shipment delays is relatively more important to the Users than it is to the Carriers or Suppliers.

Additional relationships can be found by further examination of Table 41, but they are not statistically significant.

<u>Hypotheses 2-A,B</u>

Hypothesis 2-A is concerned with the comparative factor evaluations by representatives of the following Freight User sectors: (1) durable goods manufacturers, (2) nondurable goods manufacturers, (3) retailers, and (4) freight forwarders. Table 29 presents the factor rankings developed by these sectors further broken down into representatives of larger and smaller firms. The null Hypothesis 2-A <u>cannot be rejected</u> at a confidence level of p = 0.01 when rankings of the <u>larger</u> firm subsectors are compared. Hypothesis 2-A <u>cannot be rejected</u> at a confidence level of p = 0.01 when rankings of the <u>smaller</u> firm subsectors are compared (see Table 26). This indicates that the type of business activity of Freight Users (among those

Table 29. Ranking of factors by within group means for tests of Hypotheses 2-A and 3-A[a]

Factors	Freight[b] Users	Durable Mfg. Large	Durable Mfg. Small	Nondur. Mfg. Large	Nondur. Mfg. Small	Retailer Large	Retailer Small	Forwarder Large	Forwarder Small
14. Inadequate Rate Structure	1	1	1	2	3	5	5	2	2
18. Labor Resistance	1	2	6	2	5	1	2	3	1
15. Empty Container Traffic	3	3	2	4	2	4	1	13	3
1. Nonstandard Containers	4	7	3	1	6	2	9	1	9
7. Inadequate Container Interchange	5	7	4	5	1	6	4	7	16
11. Existing TOFC Investments	6	5	4	7	11	7	16	7	6
8. Container Chassis & Shortages	7	10	6	13	6	9	2	14	14
10. TOFC Alternative	8	9	9	10	12	2	16	3	11
20. Intermodal Rivalry	9	11	9	9	10	10	9	7	12
19. Inefficient Cube vs. Vans	10	5	18	12	16	7	12	3	7
4. Divided Carrier Responsibility	10	14	13	16	3	14	9	12	3
2. Investment Requirements	12	4	11	5	9	18	12	7	15
17. Shipline Leadership	13	12	12	13	12	11	15	16	9
9. Terminal Holdups	14	14	8	17	6	12	6	14	18
3. Distribution of Benefits	15	13	15	15	14	17	19	3	7
13. Government Regulation	16	18	14	10	17	12	12	17	12
6. Intermodal Ownership Forbidden	17	14	17	8	17	15	7	7	17
16. Lack of Motor Carrier Support	18	17	15	18	14	19	20	19	3
12. Lack of Government Leadership	19	20	20	19	19	15	18	20	20
5. Lack of Land Bridge	20	19	19	20	20	20	8	18	19
Number in Sample	147	29	22	18	18	21	12	12	15

[a]Ranking: 1 = Most Important Factor.

[b]For comparison.

considered) does not have a significant influence on their rankings of the importance of factors inhibiting growth of domestic freight containerization.

The multivariate analysis test of Hypothesis 2-B shows that it cannot be rejected at a confidence level of p = 0.05. There are no significant differences in the way the business type subsectors of Freight Users evaluate the factors individually in terms of relative importance (see Table 27).

Hypothesis 3-A,B

Hypothesis 3-A involves the same population subsectors of the User business types as considered in Hypothesis 2-A. However, the question is now related to whether the size of the firm in a given business segment has a significant influence on the relative rankings of the 20 factors. Tests indicate that Hypothesis 3-A can be rejected at the confidence criterion level of p = 0.01 when comparing (1) durable goods manufacturers (larger and smaller), (2) nondurable goods manufacturers (larger and smaller), (3) retailers (larger and smaller), or (4) forwarders (larger and smaller). A "borderline" case is that of the durable goods manufacturers, where Hypothesis 3-A cannot be rejected at a confidence level of p = 0.05. (See Table 26 for test summaries and Table 29 for factor rankings.) The alternative hypothesis infers that the relative size of a given business type of Freight User does influence how representatives view the containerization inhibiting factors.

The multivariate test of Hypothesis 3-B suggests that it can be rejected at a confidence level of $p = 0.05$. The factors exhibiting significant differences (according to the univariate analysis) will be examined in light of the mean values of the respective population subsectors. The values obtained from Table 43 are presented below. For convenience in tabulation, labels for the factors are used as follows:

16. Lack of Motor Carrier Support	MTRSPT
19. Inefficient Cube vs. Vans	LOCUBE

Factor	Durable Mfg.		Nondur. Mfg.		Retailer		Forwarder	
	Large	Small	Large	Small	Large	Small	Large	Small
MTRSPT	2.689	2.636	3.000	2.500	3.047	3.000	3.333	2.066
LOCUBE	2.172	2.863	2.333	2.555	2.095	2.500	2.250	2.200

From the above it appears that lack of motor carrier support seems much more important to small forwarders than to larger forwarders; the same relationship carries for the nondurable manufacturers. In a reverse situation, the inefficient cube of containers as compared to over-the-road vans is more important to all the larger firm groups except the forwarders, who are indifferent. Large lot shipments requiring high cube are likely to be of greater concern to larger firms.

Hypotheses 4-A,B

The Freight User population can be segregated according to major freight activity, viz., shippers, consignees, shipper and consignees, and freight forwarders. The hypotheses test results parallel those for the Freight User population segregated according to business activity if relative size of firms is not considered. From the rankings of importance of factors listed in Table 30, Hypothesis 4-A cannot be rejected at p = 0.01. Within statistical significance the Freight Users rank similarly the relative importance of the 20 factors said to be retarding growth of domestic surface freight containerization.

The multivariate analysis (Table 27) suggests that Hypothesis 4-B cannot be rejected at a confidence level of p = 0.05. Differences in estimated relative importance of the factors considered individually are not significant when viewed by Freight Users segregated according to their freight activity.

Hypotheses 5-A,B

The Carrier population is segregated according to the mode served, including motor, rail, air, and marine carriers. Port authorities have been included because of their activity at the important land/marine interface. It might be expected that these diverse subgroups would rank the 20 factors differently on the basis of their respective collective evaluations. However, the Kendall's W test of the rankings in Table 31 indicates that Hypothesis 5-A cannot be rejected at p = 0.01. This means that within statistical significance the various carrier subsectors rank similarly

Table 30. Ranking of factors by within group means for test of Hypothesis 4-A[a]

Factors	Freight[b] Users	Shippers	Consignees	Shippers/ Consignees	Forwarders
14. Inadequate Rate Structure	1	1	3	2	2
18. Labor Resistance	1	4	1	1	1
15. Empty Container Traffic	3	2	2	2	8
1. Nonstandard Containers	4	3	6	5	3
7. Inadequate Container Interchange	5	5	5	4	13
11. Existing TOFC Investments	6	6	10	8	4
8. Container Chassis & Shortages	7	8	4	8	13
10. TOFC Alternative	8	11	7	10	9
20. Intermodal Rivalry	9	7	8	14	10
19. Inefficient Cube vs. Vans	10	14	8	12	17
4. Divided Carrier Responsibility	10	10	16	12	4
2. Investment Requirements	12	8	15	6	11
17. Shipline Leadership	13	13	13	11	11
9. Terminal Holdups	14	14	8	12	17
3. Distribution of Benefits	15	16	20	6	4
13. Government Regulation	16	16	14	15	15
6. Intermodal Ownership Forbidden	17	14	12	17	18
16. Lack of Motor Carrier Support	18	18	19	19	15
12. Lack of Government Leadership	19	19	17	18	20
5. Lack of Land Bridge	20	20	17	20	18
Number in Sample	147	69	26	25	27

[a]Ranking: 1 = Most Important Factor.

[b]For comparison.

Table 31. Ranking of factors by within group means for test of Hypothesis 5-A[a]

Factors	Carriers[b]	Motor	Rail	Marine	Air	Port Authorities
15. Empty Container Traffic	1	1	1	4	1	4
14. Inadequate Rate Structure	2	7	5	1	2	1
18. Labor Resistance	3	5	4	6	9	4
2. Investment Requirements	4	7	3	3	6	8
1. Nonstandard Containers	5	2	6	12	3	17
7. Inadequate Container Interchange	6	7	7	18	4	2
4. Divided Carrier Responsibility	6	12	9	5	7	3
17. Shipline Leadership	8	3	11	15	9	7
19. Inefficient Cube vs. Vans	9	4	9	17	14	12
3. Distribution of Benefits	10	6	12	7	11	12
20. Intermodal Rivalry	11	10	17	12	7	6
11. Existing TOFC Investment	12	12	8	16	5	19
8. Container Chassis & Shortages	13	10	18	8	14	15
13. Government Regulation	14	17	15	2	13	10
10. TOFC Alternative	15	16	2	19	14	18
16. Lack of Motor Carrier Support	16	14	14	9	17	15
9. Terminal Holdups	17	15	15	11	17	11
6. Intermodal Ownership Forbidden	18	17	12	14	17	8
12. Lack of Government Leadership	19	19	19	10	11	14
5. Lack of Land Bridge	20	20	20	20	20	20
Number in Sample	96	33	21	15	14	13

[a]Ranking: 1 = Most Important Factor

[b]For comparison.

the 20 factors said to be inhibiting domestic containerization.

Despite the similarity in rankings, the multivariate analysis (Table 27) suggests that Hypothesis 5-B of no differences in evaluations of given factors by the Carrier population subsectors can be rejected at p = 0.0001. There are eight individual factors where the differences in evaluations of levels of importance are significant. The mean values of significant factors listed in Table 48 are abstracted in Table 32 following for convenience in examination.

All sorts of nuances can be read into the relationships presented in Table 32. Only the major points will be presented in the analysis for the sake of simplicity. As an editorial comment, it appears that most of the differences in collective evaluations can be logically explained in terms of the relationships of the various carrier subsectors to their involvement in containerized freight traffic. Discussion of the significantly different evaluations follows:

1. Nonstandard Containers: The problem appears most important to the motor carriers, followed by rail and air, with marine carriers least concerned.
2. TOFC Alternative: The rail carriers see this factor as more important in inhibiting containerization growth than do representatives of the other modes.
3. Shipline Leadership seems most bothersome to the motor carriers, is acknowledged by the port

Table 32. Mean values of significant factors in test of Hypothesis 5-B[a]

Factors with Significantly Different Mean Values	Motor	Rail	Marine	Air	Port Authorities
1. Nonstandard Containers	1.515	2.095	2.866	2.000	3.153
10. TOFC Alternative	2.818	1.761	3.333	3.071	3.230
17. Shipline Leadership	1.666	2.476	3.000	2.714	2.153
19. Inefficient Cube vs. Vans	1.696	2.285	3.133	3.071	2.692
7. Inadequate Container Interchange	2.121	2.190	3.266	2.071	1.538
14. Inadequate Rate Structure	2.121	2.000	1.133	1.714	1.461
11. Existing TOFC Investments	2.303	2.238	3.066	2.285	3.307
13. Government Regulation	2.939	2.714	1.866	2.928	2.461

[a]Ranking: 1 = Most Important Factor.

authorities, and is seen as relatively unimportant in inhibiting domestic containerization growth by the marine carriers (logical).

4. As expected, the inefficient cube of containers vs. vans in over-the-road movements is most important to the motor carriers, followed by the rails, and not acknowledged by the marine group. Shipline leadership has been the major driving force in design and utilization of containers and this reflects in dissatisfaction by motor carriers over nonstandard and comparatively inefficient containers for over-the-road use.

5. The port authorities are probably most sensitive to inadequate provisions for container interchange, since the problem (as far as carriers are concerned) is most evident at the docks. The marine group owns a large share of their containers, so are least concerned about this factor.

6. The problems of rate structure are highly important to all sectors, but "Extremely Important" to the marine sector in inhibiting domestic containerization growth. This evaluation may reflect recent concern over rate wars.

7. Motor, rail, and air carriers are in agreement on the importance of existing TOFC investments, whereas marine and port authorities believe this factor is relatively less important.

8. Government regulation is of greatest concern to the marine sector in the comparative evaluations and this concern is mirrored to some extent by the port authorities. In the overall view of Table 32 the marine carriers (with the exception of rates and government regulation) appear less concerned about the importance of the factors considered than do the other modal representatives.

Results of Tests of Hypotheses 6 Through 11

The remaining hypotheses have been proposed in development of the relationships between firms' use of TOFC piggyback, domestic freight containerization, foreign freight containerization, and ownership of containers. Information concerning Freight User firm size, type of business, and freight activity was correlated with "Yes-No" answers to the following questions:

1. Does your firm ship or receive trailer-on-flatcar (TOFC piggyback) freight in domestic trade?

2. Does your firm ship or receive containerized freight in domestic trade?

3. Does your firm ship or receive containerized freight in foreign trade?

4. If your firm does ship or receive containerized freight, do you own most or all of the containers you use?

One additional question was asked to cover the possibility of influence on containerization practices. It was,

5. Regardless of your freight practices, are some of your goods deemed containerizable?

Of 164 replies to this last question, only four respondents indicated that their goods were not containerizable. Obviously, this is not an important factor, percentagewise, among the 37 respondents who do not use containerization in either domestic or foreign shipments.

Results are summarized in contingency tables which follow the discussions. Chi-square values are calculated according to the method presented by Chao for tests of independence of variables.[3] Calculated chi-square values which are greater than the critical values for a given confidence level, p, indicate that the observed cell numbers are significantly different from the expected cell numbers. A hypothesis of independence of universe proportions may be rejected under these circumstances.

Where a 2 x 2 contingency table is developed (with one degree of freedom) the Yates correction for continuity is applied. Refer to Table 33 following for a sample calculation. Appropriate copies of computer printout sheets are included in Appendix B.

Test of Hypothesis 6

Hypothesis 6 (H_o): The use of containerization by firms in domestic shipments is statistically independent of their use of containerization in foreign shipments.

Table 33. Contingency table and chi-square test of Hypothesis 6

Does your firm ship or receive containerized freight in domestic trade?		Does your firm ship or receive containerized freight in foreign trade? No	Yes	Total
	No	37	59	96
	Yes	15	52	67
	Total	52	111	163

CHI-SQUARE TEST OF INDEPENDENCE

Reference Table

	A	B	Total
X	a	b	a + b
Y	c	d	c + d
Total	a + c	b + d	n

In a 2 x 2 contingency table, where the degrees of freedom = 1, the Yates' correction for continuity is applied. The corrected chi-square is computed as follows:

$$x^2 = \frac{n(|ad - bc| - n/2)^2}{(a+b)(a+c)(c+d)(b+d)}$$

$$x^2 = \frac{163\ (|37x52 - 59x15| - 163/2)^2}{(96)\ (52)\ (67)\ (111)} \ ; \quad x^2 = 4.02$$

Cannot reject H_o of independence between variables at $p = 0.01$;
Can reject H_o of independence between variables at $p = 0.05$.

A 2 x 2 contingency table summarizing the answers to the two questions relating to this hypothesis is presented in Table 33. The relationship between containerization by firms in domestic and foreign shipments is borderline on the basis of a chi-square value of 4.02 with one degree of freedom. The hypothesis cannot be rejected at a confidence level of $p = 0.01$, but it can be rejected at $p = 0.05$. Examination of the "Yes-Yes" block indicates that the cell number of observations is somewhat greater than might be expected when the totals of all replies are considered.

On the basis of the results of the test of Hypothesis 6 there is a weak justification in prognosticating that further growth of containerization in foreign shipments will be accompanied by growth of containerization in the domestic freight sector.

A copy of the computer printout from which Table 33 is derived is found in Appendix B as Table 50.

Test of Hypothesis 7

Hypothesis 7 (H_o): The use of containerization by firms in domestic shipments is statistically independent of their use of TOFC (Trailer on Flatcar) piggyback.

The distribution of replies relating to the hypothesis are presented in a 2 x 2 contingency table in Table 34. The chi-square value of 0.482 indicates that the hypothesis of independence between the use of domestic containerization

Table 34. Contingency table for chi-square test of Hypothesis 7

		Does your firm ship or receive trailer-on-flatcar (TOFC piggy-back) freight in domestic trade?		
		No	Yes	Total
Does your firm ship or receive containerized freight in domestic trade?	No	21	74	95
	Yes	11	56	67
	Total	32	130	162

$x^2 = 0.482$

Cannot reject H_o of independence between variables at $p = 0.05$.

and TOFC by firms cannot be rejected. Use of TOFC does not significantly influence firms to use domestic containerization.

The appropriate computer printout is found in Appendix B as Table 51. The computer program develops and prints the row and column percentages as well as cell frequencies. The chi-square value given in Table 51 is higher than the one presented above because the computer program evidently does not use the Yates correction. However, the decision to reject the hypothesis is not changed with the higher chi-square value in this case.

Test of Hypothesis 8

Hypothesis 8 (H_o): The practice of containerization by firms in either domestic or foreign shipments is statistically independent of their ownership of containers.

Replies relating to tests of this hypothesis are presented in two 2 x 2 contingency tables, one for domestic shipments and one for foreign shipments. Only 8 of the 136 respondents indicated that their firms own most or all of their containers so the calculated chi-square values are not meaningful. Intuitively, the hypothesis of independence of use of containers in domestic or foreign shipments and ownership of containers cannot be rejected. The numbers are shown in Table 35.

Table 35. Contingency tables for chi-square test of Hypothesis 8

	Does your firm ship or receive containerized freight in domestic trade?				Does your firm ship or receive containerized freight in foreign trade?			
		No	Yes	Total		No	Yes	Total
If your firm does ship or receive containerized freight, do you own most or all of the containers you use?	No	76	52	128	No	40	88	128
	Yes	4	4	8	Yes	3	5	8
	Total	80	56	136	Total	43	93	136
		$x^2 = 0.0201$				$x^2 = 0.007$		

Chi-square not meaningful because of small numbers in "Yes" cells.

The questionnaire confirms the fact that few Freight Users own their containers. They are leased from or provided by carriers or obtained from leasing firms. This situation may partially explain the ranking of the "Investment Requirements" factor as No. 12 by Freight Users as compared to No. 4 in importance by Carriers in Table 28-B.

Test of Hypothesis 9

Hypothesis 9 (H_o): The use of containers by Freight Users in either domestic or foreign service is statistically independent of the type of business in which they are engaged.

The relationships between containerization practices and the Freight User type of business are presented in two 2 x 4 contingency tables in Table 36. The chi-square value of 9.230 with three degrees of freedom indicates that the hypothesis of independence of domestic containerization and type of business cannot be rejected at $p = 0.01$ but can be rejected at $p = 0.05$. The high chi-square value is contributed to primarily by the durable goods manufacturers. They report only about two-thirds the activity in domestic freight containerization that might be expected on the basis of the total sample distribution. The nondurable goods manufacturers, retailers, and forwarders are almost evenly divided between those who do and those who do not use domestic containers.

Table 36. Contingency tables for chi-square test of Hypothesis 9

		Type of Firm				
		Dur. Mfg.	Nondur. Mfg.	Retailer	Forwarder	Total
Does your firm ship or receive containerized freight in domestic trade?	No	50	18	17	10	95
	Yes	20	18	15	13	66
	Total	70	36	32	23	161

$x^2 = 9.230$ Can reject H_o of independence between variables at $p = 0.05$.
Cannot reject H_o of independence between variables at $p = 0.01$.

		Dur. Mfg.	Nondur. Mfg.	Retailer	Forwarder	Total
Does your firm ship or receive containerized freight in foreign trade?	No	26	9	10	7	52
	Yes	45	28	22	17	112
	Total	71	37	32	24	164

$x^2 = 1.976$ Cannot reject H_o of independence between variables at $p = 0.05$.

In foreign shipments the chi-square value of 1.976 indicates that the hypothesis of independence of containerization and type of business cannot be rejected at $p = 0.05$. Roughly, twice as many firms use foreign containerization as those who do not in each business category.

The relationships of both business type and size were developed in a two-way analysis by the computer program. It required eight tables of computer output. Only one table is included as representative of the hypotheses tests in Appendix B as Table 53.

Test of Hypothesis 10

> Hypothesis 10 (H_0): The use of containers by Freight Users in either domestic or foreign service is statistically independent of the relative sizes of the businesses.

The hypothesis is tested with four 2 x 2 tables related to domestic freight and four 2 x 2 tables concerning foreign shipments. Each of the durable goods manufacturer, nondurable goods manufacturer, retailer, and forwarder sectors is tested at larger and smaller size classifications in Table 37. The chi-square values indicate that the hypothesis of independence between domestic container usage and size of firm cannot be rejected at $p = 0.05$ for any type of firm.

Table 37. Contingency tables for chi-square test of Hypothesis 10

		Type and Size of Firm							
		Dur. Mfg.		Nondur. Mfg.		Retailer		Forwarder	
		Lg.	Sm.	Lg.	Sm.	Lg.	Sm.	Lg.	Sm.
Does your firm ship or receive containerized freight in domestic trade?	No	21	29	8	10	8	9	6	4
	Yes	11	9	11	7	12	3	5	8
	Total	32	38	19	17	20	12	11	12
Calculated x^2 =		0.973		1.003		3.689		1.051	
Can H_o be rejected at p = 0.05?		No		No		No		No	
		Dur. Mfg.		Nondur. Mfg.		Retailer		Forwarder	
		Lg.	Sm.	Lg.	Sm.	Lg.	Sm.	Lg.	Sm.
Does your firm ship or receive containerized freight in foreign trade?	No	5	21	1	8	4	6	5	2
	Yes	28	17	18	10	16	6	6	11
	Total	33	38	19	18	20	12	11	13
Calculated x^2 =		12.244		7.709		3.142		2.608	
Can H_o be rejected at p = 0.05?		Yes p = 0.01		Yes p = 0.01		No		No	

va
ti
an
be
co
th
th
t
f
n
I

In the case of foreign containerization, chi-square values indicate that the hypothesis of independence of relative size _can be rejected_ at $p = 0.01$ for both the durable and nondurable goods manufacturers. The hypothesis _cannot be rejected_ at $p = 0.05$ for retailers or forwarders. Use of containers in foreign service is significantly greater among the larger firms in the two manufacturing sectors than among their smaller counterparts. More of the larger forwarders than might be expected reported that they do not engage in foreign containerization. However, these respondents may not engage in any foreign freight forwarding activity.

Test of Hypothesis 11

> _Hypothesis 11_ (H_o): The use of containers in either domestic or foreign service is statistically independent of the type of Freight User activity (shipper, consignee, shipper and consignee, or forwarder).

The hypothesis is tested with two 2 x 4 contingency tables as shown in Table 38. The chi-square value of 2.073 indicates that the null hypothesis of independence of container usage and freight activity in the domestic area _cannot be rejected_ at $p = 0.05$. Likewise, a chi-square value of 1.030 signifies that the hypothesis _cannot be rejected_ at $p = 0.05$ in the case of foreign shipments. With the exception of a higher than expected usage by forwarders in domestic shipments, all of the cell observations are

Table 38. Contingency tables for chi-square test of Hypothesis 11

		Type of Freight User Activity				
		Shipper	Consignee	Shipper & Consignee	Forwarder	Total
Does your firm ship or receive containerized freight in domestic trade?	No	39	16	15	10	80
	Yes	26	10	10	13	59
	Total	65	26	25	23	139

$x^2 = 2.073$ Cannot reject H_o of independence between variables at $p = 0.05$.

		Shipper	Consignee	Shipper & Consignee	Forwarder	Total
Does your firm ship or receive containerized freight in foreign trade?	No	20	9	5	7	41
	Yes	47	17	20	17	101
	Total	67	26	25	24	142

$x^2 = 1.030$ Cannot reject H_o of independence between variables at $p = 0.05$.

close to what might be expected on the basis of sample distributions.

One of the four computer printout tables which was used to develop the contingency tables is included in Appendix B as Table 55.

Tests for Biases in the Questionnaire Survey

Biases in the Order of Questionnaire Factor Listing

The respondents to the research questionnaire were asked to indicate their estimate of the relative importance of each of twenty factors said to be inhibiting growth of containerization in domestic surface freight shipments. The possibility exists that the order in which the factors are listed can bias the survey results. For example, the first-listed factors might be evaluated as of higher importance when compared to those appearing farther along in the questionnaire.

In order to test listing order bias the sequence of factors was reversed in most of the questionnaires that were sent out with the follow-up mailing. Whereas the factor, 1. NONSTANDARD CONTAINERS was first in the original mailing (Form I), and the factor 20. INTERMODAL RIVALRY was last, the whole list was inverted (Form II). The question on intermodal rivalry became the first one in the follow-up mailing. The punched cards used for data input in the computer programs were coded to identify which form was returned.

A comparison of the replies from the two forms is shown in Table 39. The factors are ranked by within group means, as had been done in testing Hypotheses 1-A through 6-A, and Kendall's coefficient, W, was determined. On the basis of the chi-square value = 35.0 and degrees of freedom = 19, the hypothesis of differences in rankings for the two lists <u>can be rejected</u> at p = 0.01+. Five of the first six ranked factors appear at the top of both lists. Four of the last six factors appear at the bottom of both lists. However, there is some indication of the possible effects of list reversal: Factor 20 (Intermodal Rivalry) moved from 13 to 8th place in relative importance and Factor 3 (Distribution of Benefits) moved from 7th to 18th place in Form II results. Overall, the displacements were not sufficient to be considered significant.

Differences in the populations comprising the two questionnaire form sectors could have affected the test results. Since there were only 44 replies used for each type form received after the second mailing, segregation into respondent activity sectors would have resulted in sample groups too small to be meaningful. The test which was performed can be used to indicate with some degree of assurance that the order of listing of factors was not an important bias in the results obtained.

Table 39. Ranking by within group means to test bias of factor listing order[a]

Factors	Initial Form I	Reversed Form II
14. Inadequate Rate Structure	1	1
15. Empty Container Traffic	2	1
2. Investment Requirements	3	7
7. Inadequate Container Interchange	4	6
1. Nonstandard Containers	5	4
18. Labor Resistance	6	3
3. Distribution of Benefits	7	18
17. Shipline Leadership	8	13
4. Divided Carrier Responsibility	9	10
19. Inefficient Cube vs. Vans	9	14
6. Intermodal Ownership Forbidden	11	14
8. Container Chassis & Shortages	12	8
20. Intermodal Rivalry	13	8
11. Existing TOFC Investments	14	5
13. Government Regulation	15	16
9. Terminal Holdups	16	10
12. Lack of Government Leadership	17	20
10. TOFC Alternative	18	10
16. Lack of Motor Carrier Support	19	17
5. Lack of Land Bridge	20	19
Number in Sample	44	44

Sum of Squares = S = 2446

Kendall's W = 0.920

$x^2 = 35.00$

<u>Can</u> reject hypothesis of differences in rankings @ p = 0.01+

[a]Ranking: 1 = Most Important Factor.

Biases in Replies to the Follow-Up Mailing

Students of research by questionnaire comment that replies to follow-up mailings can be biased when compared to results of initial mailings. Differences in the level interest in the survey subject are given as one cause of bias. This study was monitored for such bias by coding the computer data cards representing questionnaires received before and after the follow-up mailing. Replies obtained from the Freight User category were segregated and ranked according to within group mean values indicated for the 20 factors said to be influencing growth of domestic containerization. The rankings of the two groups are shown in Table 40. Determination of Kendall's W and the chi-square value suggest that the hypothesis of differences in rankings between the groups can be rejected at $p = 0.01+$. The top six factors appear in the rankings of both groups and four of the bottom six factors are similarly ranked.

Here again differences in the subsector makeup of the two test populations could have an important influence on the analysis. However, in view of the results, it can be stated with reasonable assurance that the need for a follow-up letter to elicit replies did not significantly bias the findings of the study.

Table 40. Ranking of factors by within group means to test bias of follow-up mailing[a]

Factors	Initial Maining	Follow-Up Mailing
14. Inadequate Rate Structure	1	3
18. Labor Resistance	2	1
15. Empty Container Traffic	3	2
1. Nonstandard Containers	4	3
11. Existing TOFC Investments	5	6
7. Inadequate Container Interchange	6	5
10. TOFC Alternative	7	12
20. Intermodal Rivalry	8	11
8. Container Chassis & Shortages	9	7
4. Divided Carrier Responsibility	10	10
19. Inefficient Cube vs. Vans	11	7
2. Investment Requirements	12	12
9. Terminal Holdups	13	16
17. Shipline Leadership	14	12
3. Distribution of Benefits	15	18
13. Government Regulation	16	12
6. Intermodal Ownership Forbidden	17	9
16. Lack of Motor Carrier Support	18	17
12. Lack of Government Leadership	19	20
5. Lack of Land Bridge	20	19
Number in Sample	107	27

Sum of Squares = S = 2478

Kendall's W = 0.932

$x^2 = 36.19$

Can reject hypothesis of difference in rankings @ p = 0.01+

[a]Freight Users replies only. Ranking: 1 = Most Important Factor.

Summary of Replies to an Open-Ended Question

It was recognized that the 20 factor questionnaire concerning inhibitors to growth of domestic containerization could not be all inclusive. To allow recognition of additional factors by respondents, the following open-ended question was posed:

> If there are any factors which have not been covered in the questionnaire which you feel are important in inhibiting growth of containerization in domestic surface movements, or if you have any additional comments to offer, please note them on the remainder of this sheet.

Some comments merely gave further emphasis to the factors listed in the questionnaire. Some offered strong disagreement as to the validity of given factors. Comments were made which relate primarily to marine or air movements. Those concerning labor impediments were mainly directed to dockside activities. Some remarks offered additional insight into the factors presented in the study. These latter points, as well as those which had not been considered in the questionnaire have been roughly segregated into four categories (which are not mutually exclusive). They are quoted below pretty much as stated.

Economic Factors

> Port Authority: Containers are designed to withstand stacking and sea voyages. It is not necessary to have such strong, heavy equipment for domestic movement, with resultant loss of cubic space as compared to a truck body of the same weight.

Motor Carrier: The cubic limitations of the container combined with the motor carriers proportion of the through movement does not provide a profit.

Motor Carrier: In most of the container interchange contracts we have had occasion to review, we feel the charges for rental, etc., are unrealistically high; in many instances 4 to 5 times our daily cost of owning trailers.

Rail Carrier: The railroads should not be expected to handle steamship line containers free-of-charge from port area to inland loading points unless the steamship lines are willing to relieve the railroads of per diem payments while containers are under load. Steamship lines . . . also vigorously protest the application of charges for the handling of empty containers to inland loading points.

Equipment Supplier: For rail or highway carriers to abandon the wheels at some point of the trhough haul, absent a sound operating reason, would be the height of economic folly. It must be remembered that you don't "leave the wheels behind," in the popular misconception, you "send the wheels ahead." Simple arithmetic reveals that for a captive road-rail-road containerized operation between Chicago and New York, operating six days a week, at least two more sets of wheels are required than sets of containers. If the pairs of points are increased, the excess of wheels also increases.

Equipment Supplier: Demand for the "Flexi-Van" rail cars for hauling containers has fallen because railroads don't want or can't afford to make the capital investment required. This system is practical and ties in well with the ocean container carriers.

Equipment Supplier: Perhaps you should look a little closer at the "operating difficulties" incurred by operators requiring container handling facilities at too many smaller stations; utilization rates suffer because of the complexities of having various types of idle ground support equipment available at major container stations.

<u>Retailer</u>: We have found a marked reluctance on the part of carriers, whether they be rail or truck, to be responsible for loss or damage in a container. The general approach has been that the other carrier or shipper or receiver contributed to the damage and therefore, they were not liable. If the rate structure is such that you have taken into consideration additional liability and high rate, it is not advantageous to use containers, or to push this media.

<u>Retailer</u>: There is not an economic approach for containerization in the food industry other than TOFC.

<u>Equipment Supplier</u>: The proven transportation savings through use of containers by railroads only applies to unit train or trainload operations and not in normal train service.

<u>Port Authority</u>: Lack of proper motor carrier published tariffs for containers in Midwest and lack of import/export rate system for Great Lakes, allowing discriminatory rates favoring other coasts inhibits Great Lakes from contributing to container movement's growth in the national transportation picture.

<u>Forwarder</u>: No one (or at least very few) does anything to reduce the gross waste and inefficiency in the traffic area. Rate increases go into prices and customers complain very little--no complaints from shippers, consignees and the consuming public means no action. Problem combines public apathy to the cost of transportation with the inadequacy of many traffic people.

<u>Equipment Considerations and Availability</u>

<u>Motor Carrier</u>: One major motor carrier problem is inadequate maintenance of containers and chassis on the part of ocean carriers owning this equipment.

<u>Forwarder</u>: The imbalance of traffic almost precludes our investing in containers for our own use. However, if there were ways around this imbalance, such as are present in TOFC movements, whereunder we can rent or lease trailers from the railroads in a one-way movement, there would be

many instances where we could take advantage of containerization benefits.

Rail Carrier: There are enough standard containers in service to satisfy existing needs, however, the real problem we experience is the lack of standard chassis.

Motor Carrier: We have experimented with "twin-twenties" (tandem 20 foot containers) and found that mechanical problems of joining (and uncoupling) into 40 foot road trailers more than offset any economics in our operations.

Equipment Supplier: Lack of standard interchange agreements (for containers) between all modes inhibits containerization growth.

Rail Carrier: Steamship lines stand to benefit from intermodal and containerized transportation as much or more than anyone but they do not seem willing to provide adequate equipment for rail and highway requirements.

Forwarder: The sad truth is that many containers simply are not designed for the cargo they are supposed to carry. Once you achieve good container design, then the containers are no longer intermodal.

Motor Carrier: Motor carriers do not want to get involved with containers that do not provide for about the same cube as their own equipment. They do not care to handle units coupled together as a unit.

Coordinative Activities

Retailer: Primary deficiency appears in the lack of a unified approach from various transport segments. Possibly a nudge in the form of a governmental grant or subsidy would establish a workable goal.

Equipment Supplier: Containerization, as an intermodal concept is obviously most practical. Political reasoning, however, will most certainly delay truly economic intermodal transportation systems from being developed. Unfortunately, those involved are a long way from reaching agreement between themselves.

It is this writer's opinion that the Department of Transportation will be forced, or at least should be forced, to take a far more active part in directing this crucial industry, but regret that they are not doing so at the present time. Handing down authority through the associated bodies is not the answer. No common agreement can ever be reached when responsibilities are not delegated with total understanding of what is involved.

Equipment Supplier: One of the main reasons for the lag in containerization at the present time is the unwillingness of inland carriers and shippers to get together.

Retailer: A 20 foot container program would be most helpful in consolidating LTL shipments at major supplier cities. The time required to consolidate a full load for a 40 foot container is too great and impedes our scheduling of inbound merchandise. A container could be dispatched more frequently and the cost remain the same if our container were married with another container routed to the same city.

Motor Carrier: Shiplines sell by cube, thereby encouraging shippers to load to full capacity without regard to weight restrictions which must be met by highway users. Example: 100,000 pounds loaded in 20 foot container; must transfer to multiple vans, thereby defeating concept of containerization.

Retailer: A pick-up system is needed. Containers take up too much space after emptying--there is too long a wait for pick-up. Containers are no good for short haul freight.

Government Regulation

Forwarder: The most significant factor is interference of the Government through ICC, CAB, and PUC controls which overprotect the sick, outdated transportation companies. If forwarders were able to issue tariffs rather than utilize ICC controlled present tariffs, then containerized mode would flourish. However, at present, the existing common carriers can block the growth simply by overpricing their services and making a containerized rate non-competitive.

Motor Carrier: A serious problem in domestic transportation is the lack of uniformity in state regulations in regard to equipment.

CHAPTER V--FOOTNOTES

[1]D. J. Wright, Jeremy D. Finn's Multivariance--Univariate and Multivariate Analysis of Variance and Covariance: A FORTRAN IV Program. Issued as "Occasional Paper No. 8" (East Lansing, Michigan: Office of Research Consultation, College of Education, Michigan State University, March, 1970). Based upon documentation by Jeremy D. Finn, Department of Educational Psychology, State University of New York at Buffalo.

[2]A. R. Holdridge, Technical Report No. 12: Four-Dimensional Contingency Tables--NUCROS (East Lansing, Michigan: Computer Institute for Social Science Research, Michigan State University, February, 1968).

[3]L. L. Chao, pp. 288-292.

CHAPTER VI

SUMMATION OF THE STUDY

The previous chapters have been concerned with presenting a stepwise description of the research project. From a search of current literature, twenty factors were developed which are claimed to be inhibiting growth of containerization in domestic surface freight shipments. A questionnaire was submitted to representatives of Freight User, Freigh Carrier, and Containerization Equipment Supplier sectors for their evaluation of the relative importance of these factors. Questions were also asked concerning Freight Users' activities relating to containerization. Questionnaire replies were analyzed in order to test hypotheses relating to details of the domestic containerization growth problem. It remains now to form a summation which will offer useful guidance for those who are concerned with developing solutions to the problem.

A structured interview outline was developed to relate the opinions and recommendations of those actively involved in containerization to the findings of the research. Men representing different outlooks were interviewed and their comments are consolidated in Appendix C.

Summary of the Study Findings

Underlying Considerations of Factors Inhibiting Containerization

The points summarized in this section relate to the results of the tests of Hypotheses 1-A,B through 5-A,B. They concern the evaluation by the test population of the 20 factors said to be inhibiting growth of domestic surface containerization.

In order to develop a rough guide to the underlying considerations involved in ranking of the factors, a simple correlation exercise was performed. In Chapter IV the 20 factors were divided into five categories.[1] The groupings were as follows:

1. Economic Factors:
   - INVESTMENT REQUIREMENTS
   - DISTRIBUTION OF BENEFITS
   - TERMINAL HOLDUPS
   - TOFC ALTERNATIVE
   - EXISTING TOFC INVESTMENTS
   - INADEQUATE RATE STRUCTURES
   - EMPTY CONTAINER TRAFFIC AND TARIFFS
   - INEFFICIENT CONTAINER CUBE vs. VANS

2. Equipment Availability:
   - NONSTANDARD CONTAINERS
   - CONTAINER AND CHASSIS SHORTAGES

3. Government Regulation:
   - GOVERNMENTAL REGULATION
   - LACK OF GOVERNMENT LEADERSHIP
   - INTERMODAL OWNERSHIP FORBIDDEN

4. Labor:
   - LABOR RESISTANCE

5. Coordinative Activities:
   LACK OF LAND BRIDGE
   DIVIDED CARRIER RESPONSIBILITY
   INADEQUATE CONTAINER INTERCHANGE
   LACK OF MOTOR CARRIER SUPPORT
   SHIPLINE LEADERSHIP
   INTERMODAL RIVALRY

Elements of these groupings were assigned the rankings of factor importance from the Freight User, Carrier, and Equipment Supplier sectors as shown in Table 28-B.[2] An "index-number" dependent upon the location of the factors in the rankings was determined for each factor grouping. The derived relative levels of concern are indicated in the listing below, with the most important group shown at the top:

	Users	Carriers	Equipment Suppliers
Most Important	Economic	Economic	Economic
	Labor	Labor	Labor
	Equipment	Coordination	Coordination
	Coordination	Equipment	Equipment
Least Important	Government	Government	Government

It is not unexpected that economic considerations would be considered by all sectors as being most important in inhibiting growth of domestic containerization. The ranking of "Labor" as second most important does not fit with the comments obtained in personal interviews. There was agreement that labor is a problem in dockside activities relating to container movements but it was not considered highly important where motor and rail movements are involved. When making an evaluation the respondents may have been influenced by militance among dockside workers.

Except where Freight Users show greater emphasis on importance of equipment availability than on coordinative activities, the basic considerations appear to be pretty much agreed to by all the major population sectors. The lesser importance of government regulation is particularly noticeable in all rankings.

Discussion of Top-Ranked Factors

The summary discussion will be limited to those factors ranked highest with respect to individual relative importance. Table 28-B shows surprisingly close agreement in top rankings.[3] The reader can satisfy his particular interests by examining the rankings further and also by digging into relationships which develop as the population is broken down differently in Tables 29 through 31.

Factor 14. INADEQUATE RATE STRUCTURE is considered highly important in inhibiting growth of domestic containerization. Furthermore, there is very close agreement as to the relative importance of this factor, based upon mean values of 1.85, 1.79, and 1.89 for the User, Carrier, and Equipment Supplier segments, respectively. It cannot be concluded, however, that judgments are made on the same grounds. Users look for more rate incentives to use containers. Carriers disagree on how the savings should be distributed and whether costs justify rate reductions. Equipment Suppliers may recognize the problem through their association with the other two sectors.

Factor 15. EMPTY CONTAINER TRAFFIC is listed about equally in line of importance with the LABOR RESISTANCE factor. In Table 31 the motor, rail, and air carriers all put the "dead head" factor at the top of the list, while the less-affected marine carriers put it fourth. Empty container traffic appears most bothersome to the motor carriers, who assign a mean value of 1.48 (on a scale of 5) to this factor. Rails are close behind with a 1.66 mean. An interview comment that the "dead head" problem is also present for trailers used in TOFC piggyback is pertinent. So is the comment that empty hauls can best be cured by marketing.

Factor 1. NONSTANDARD CONTAINERS appear to be an important problem to Users and Carriers but less important to Equipment Suppliers, as indicated in Table 28-B. The listings in Table 31 indicate that the problem is most important to the motor group and of comparatively little importance to the marine sector. Interviews and answers to the open-ended question bear out the concern of the motor carriers, who have little flexibility in their equipment to cope with nonstandard boxes. On the other hand, the marine carriers appear less concerned because they generally own their containers, or at least control and limit the choice of container size to the limitations of containership cell dimensions.

Factor 7. INADEQUATE CONTAINER INTERCHANGE finds close agreement among all three sectors, both in terms of ranking and in between mean comparisons. The problem is probably most pronounced where marine shipments are involved since the need to match ownership of a container with ownership of the vessel scheduled to make the trip can result in missing the vessel departure. An exchanged container would have served the shipper's purpose just as well. Frequent comments concerning the need for container pools reflect concern over this factor.

Factor 11. EXISTING TOFC INVESTMENTS show agreement between Users and Equipment Suppliers that this is the next most important factor but the Carriers give it a considerably lower priority (mainly because of very low ranking by the marine sector). A practical demonstration of the influence of existing investment is the decision by the Southern Railroad to promote container services, partly because they had not previously invested in TOFC piggyback. On the other hand, rail carriers who have heavy investments in TOFC piggyback equipment which may be incompatible with COFC container service resist the change.

There is no point in rehashing the details of all of the hypotheses tests, but some overall generalizations should be worthwhile. With one exception, ranking of the factors according to relative importance is not greatly influenced by how the population is segmented. The exception: the comparative size of the firm within a given business type apparently makes a difference in the respondents' outlooks.[4] The durable goods manufacturers have the closest agreement between firm size segments (Kendall's W = 0.874) while the forwarders are farthest apart (Kendall's W = 0.700).

When agreements on relative importance of individual factors are examined (Hypotheses 1-B through 5-B) there is less uniformity of judgment. The major subgroups (User, Carrier, and Equipment Supplier) are not in agreement on four factors which have statistically significant differences. Size within the business type subgroup is related to significant differences of evaluations on two factors. The most obvious differences in individual factor evaluations occur in the carrier group, where eight significant differences are listed.[5]

In the overall view of the evaluations of factors reported to be inhibiting growth of domestic containerization it can be said that there is general agreement as to the relative importance of the various factors, regardless of how the population is segmented, but close inspection reveals points of significant differences. The general agreement relates to the common primary concern over economic considerations while the individual differences reflect special needs of the various population segments.

Relationships in Containerization Practices

The most obvious relationships developed from the survey will be discussed first. Among Freight Users who engage in containerized traffic, only 8 of the 136 respondents stated that they own most or all of the containers in their use. The other obvious relationship concerns the containerizability of Freight Users' goods. Only 4 out of 164 respondents did not state that some or all of their goods was containerizable. Therefore, judgments as to containerizability of goods do not appear to be important in inhibiting growth of domestic freight containerization.

In the review of literature it was brought out that containerization first developed in the domestic area and that a short time ago it began to enjoy a rapid growth in the foreign traffic sector. Hypothesis 6 explores the possibility of a relationship between firms' use of containerization in foreign shipments and their use of the art in domestic movements. The conclusion is that there is a weak relationship between use of containerization in the foreign and domestic freight sectors (can reject H_0 of independence between variables at $p = 0.05$). Whether this relationship is due to the early existence of domestic container traffic or whether foreign practice begets domestic practice cannot be stated. However, the indicated inter-relationship suggests that those who would benefit in either of the sectors should work together for common gain.

The possibility that TOFC piggyback use would be related to domestic containerization was explored in testing of Hypothesis 7. The relationship does not appear to be significant.[6]

When use of containers is segregated according to business types among Freight Users there is a weakly significant relationship (at $p = 0.05$) in the domestic area, primarily because of lagging interest by the durable goods manufacturers. In the foreign shipments field, however, there is no significant relationship.[7] Both the durable and nondurable goods manufacturers show significant relationships between business size and use of containerization in foreign freight. The smaller firms are less inclined to use containers than might be expected on the basis of the total sample size. There are no other significant relationships in either foreign or domestic movements in this size comparison.

Finally, segregating the Freight User population according to freight activity (shipper, consignee, shipper and consignee, and forwarder) reveals no significant containerization relationships in either domestic or foreign freight.

Additional Factors from Open-Ended Question and Interviews

There were a few factors presented in answers to the open-ended question and in the interviews which were not considered in the questionnaire. An important item is the difficulty of assigning liability for damage to containers or their contents. This was inferred but not spelled out in Factor 4: DIVIDED CARRIER RESPONSIBILITY. The problem is particularly bothersome to both the shipper and consignee. As stated by one respondent, "the general approach has been that the other carrier, or shipper, or receiver contributed to the damage and therefore, they were not liable." Since the containers are kept sealed as much as possible to reduce pilferage and damage, the problem of concealed damage is aggravated. The problem is further compounded by the lack of established rules or agreements for sharing or assigning liability. One solution is offered by the "integrated forwarder" who assumes liability for all segments of the transfer which he controls.

Another factor mentioned is a general lack of interest by shippers. This was reinforced with comments that "few do anything to reduce the gross waste and inefficiency in the traffic area," and "motor carriers don't feel pressure from shippers to move containers." The problem is approached in Factor 20 of the questionnaire, INTERMODAL RIVALRY (no carrier sells intermodal operations; each one tries to sell his own mode). By a small margin the User sector feels this situation is more important than do the Carrier or Equipment sectors, and it falls about midway in the ranking of all factors.

At least one more factor is indicated: lack of familiarity with the practice, especially by shippers. Two comments that relate to this problem are, "the main problem is going to be the training of people," and "specialists being assigned by the various modes and liaison developed between the modes will create communication, the lack of which is a problem now."

Conclusions

The Methodology

First, a few conclusions are in order with respect to what has been accomplished with the research methodology employed. Limitations of the research will be discussed separately. In determining the relative importance of factors inhibiting the growth of domestic containerization the researcher is faced with (a) a diversity of opinion concerning a large number of factors, (b) a heterogenous population with diverse interests in freight activity, and (c) a population which is spread widely across the country and whose geographic location might influence opinion in the study area. The first conclusion is that in the face of these conditions, the survey questionnaire has proven to be a satisfactory research tool for the development of an identifiable set of evaluative relationships.

The second conclusion is that the use of an equal interval numerical rating scale is a useful tool for quantifying opinion concerning an intensity factor involving levels of importance. The results of numerical rating can readily be used as input to a broad range of available computer programs. Considerably greater depth of analysis is available through the use of these programs than could be obtained without a quantitative approach.

Finally, the limitations of unstructured, open-ended questions are apparent. The results are difficult to quantify and often even difficult to correlate. Diversity of opinion can be recognized but it cannot be readily measured. The main advantage of such questions is that they often uncover areas that might not have been considered if the investigation had been completely structured.

Conclusions Derived From the Study

A number of conclusions have been built into the summary of the study and they will be mentioned only briefly to avoid repetition. Other points have not been previously spelled out but can be deduced from the data presented. The conclusions are listed without particular regard to order of importance.

1. Economic considerations are predominant in influencing and retarding the growth of containerization in domestic surface freight shipments. The rate structures are not designed to promote the practice and the carriers do not believe that there are sufficient savings to justify rate reductions. The domestic carriers believe that benefits

accrue primarily to the marine sector when containers are used in overseas shipments and that they do not share equitably in handling the domestic portion of such transfers. A major share of savings occurs at the dockside, where containerization allows quick turnaround of expensive containerships. A similar savings opportunity is not available in the domestic area without the requirement of major investments for equipment to handle large numbers of containers expeditiously at the rail terminals.

Empty container traffic is burdensome to the domestic carriers, particularly where it is involved in the domestic portion of an overseas shipment. Lack of container interchange agreements aggrevates the problem. Boxes are often dead headed to a location where available containers belonging to other owners could be used if exchange were permitted. Leasing would alleviate the problem if pools were adequate in size and if lease rates could be reduced to attractive levels.

A major factor is the readily available alternative of TOFC piggyback. This is the method in common use where intermodal transfers are justified. A switch to containerization involves effort on the part of the traffic managers, plus the unmeasured possibility of economic disadvantage. The benefits are frequently related to special situations such as the need for tying a container directly into a production line, the need for stacked storage of the boxes, or some similar need which cannot be met with van trailers.

The most likely area of rapid development in the domestic sector appears to be in the use of containers on unit trains dedicated to mixed TOFC/COFC or all COFC service. Quick turnarounds made possible with proper handling equipment and tight scheduling can result in deliveries of goods over long distances (500 miles or more) which cannot be met by other means. Such service can produce the savings to the shippers which make containerization attractive to them.

2. It appears that there is need for a set of "domestic container standards" which can be applied to boxes which are not intended for overseas transfer. These containers could be standardized to larger cube dimensions so as to be competitive with the over-the-road vans. Lighter construction, where stacking is not required, would allow them to be built cheaper, thus reducing lease or purchase costs. The materials would not have to be resistant to the corrosion of ocean spray and they might be outfitted with devices which would make it easier to secure and handle them in domestic freight yards.

If the 20 foot container is continued in use by marine carriers it will have to be modified to allow for easier coupling in order to be more readily acceptable to the motor carriers. An alternative is to phase out the smaller boxes and the trend appears to be in this direction.

3. Leadership in the marine container program has been held by the major ocean carriers. Organized leadership for container operations is not evident among the domestic

carriers. There are differences of opinion as to whether TOFC or COFC piggyback should be promoted by the rail carriers. The motor carriers would just as soon stay with the wheeled vans since they feel that they have better control over the long haul market than they would have if container usage were to grow. The rail flatcar is capable of providing cheaper service for intermediate or long hauls.

Governmental agencies have not provided significant leadership in promoting use of containers. The agencies are more concerned with day to day regulation than with longer term development needs of the transportation industry. The Department of Transportation is just beginning to work in this area and their Office of Facilitation has some developmental projects under way.

The trade associations tend to look to the needs of the modes they represent and there has not been effective cooperation among them in promoting containerization. Where cooperative effort has been obtained the results have been useful. Accomplishments include the contributions to container standardization and the Trailer Train approach to standardized rail cars for piggyback service.

4. Because of the lack of cooperation there exists a lack of coordination as well. Boxes moved from the West Coast without wheels have to be removed from flatcars and fitted with chassis before being accepted by eastern railroads. The consignee has difficulty in assigning responsibility for damage which occurs to goods in transit.

Schedules are not coordinated for minimum delays in transfer at modal interfaces. Container inspections and maintenance are not coordinated. A container pool similar to the rail car pool does not exist. Dead head movements are greater than necessary and equipment utilization rates are less than optimum. There is no organized nationwide marketing program to sell the benefits of containerization to the shippers. There is no program of education in the art for the traffic managers who make freight decisions. The situations mentioned lead to frustration for those innovators who want to obtain the inherent advantages of containerized shipments.

5. The system is experiencing growing pains. Adequate equipment handling facilities have only recently been installed at the major freight centers and most of these have been provided primarily for servicing of marine movements. The high equipment costs and lack of capital funds have limited expansion of handling facilities at inland locations. Until adequate facilities are available to handle container traffic the practice will be retarded.

The container itself is still in a developmental stage. Potential buyers are reluctant to make major commitments for equipment that may be economically obsolete in a short time.

Regulations are still being evolved. The major regulatory agencies are not in agreement nor are they coordinated in their task of controlling practices in the growing program. Basic principles relating to consolidations, mergers, and intermodal ownership are in a state of evolution. This situation can affect the long-term roles played by the transportation sectors in further development of the art.

Limitations of the Study

The Use of a Mail Survey

The mail survey makes it possible to contact a diverse population scattered over a broad geographic area. However, it also has certain inherent disadvantages which influence the results. Since the questionnaire must be reasonably short the questions must be structured. There is no allowance for discussion of all the variations of meaning and interpretation which may occur to the respondent in answering a question. This problem is best handled in a face-to-face interview. For example, a high importance level was given to the labor resistance factor by all sectors responding to the questionnaire but labor was appraised as no major problem by those interviewed. It is likely that the questionnaire was processed with some bias toward problems in the marine use of containers.

The questionnaire was distributed randomly to population sectors containing many representatives. An effort was made to direct it to those in responsible charge of traffic activities. However, it must be recognized that these people have different levels of exposure to both domestic and foreign containerization. The opinions are all lumped together in average replies which might be significantly different than those obtained solely from "experts." However, a true cross-section of opinion is available for anyone who is interested in promoting the art of containerization.

Finally, the researcher has no actual control or firm knowledge concerning who actually fills out the questionnaire or the circumstances under which it is processed. An offer of a summary of the findings partly overcame this problem because the respondent indicated his name and title on the request form. In some cases the questionnaire was passed on to someone who may have been less busy rather than more qualified than the addressee. It can also be assumed that some respondents gave the questionnaire careful consideration while others just moved down quickly through it in order to get another piece of mail cleared from the desk top. These factors would tend to make the results less meaningful and the effect was best countered by the use of as large a random sample as was practical.

Nonparametric Statistics and Behavioral Research

The thrust of the research project has been the gathering of opinion. Unfortunately, opinion is not easily quantified. It can cover a continuum of values on any given question. The methodology employed assumes that the factor of intensity, as indicated by the level of importance choice, can be approximated closely enough so that arithmetic manipulation of the concensus is acceptable. Since the results of such manipulations appear logical and explainable, there is some assurance that the approach has been reasonable and that the results can be usefully applied.

Researchers in the behavioral area share a common problem of deciding whether to use parametric statistical methods with nonparametric data. Authorities indicate that such a choice is justified because the opportunities for more powerful analysis outweigh the limitations of the nonparametric test treatments. This study has employed both approaches and the results do not appear to be incompatible. However, the reader must be cautioned that validity of the conclusions is influenced by assumptions of normality of distribution and homogeneity of variance, neither of which are readily measured.

Recommendations for Further Work

Research on Economics of Containerization

The greatest need for further research is in work relating to the economics of containerization. Such effort should help to alleviate the economic problems which are believed to be most important in inhibiting growth of domestic containerization. More work is needed to quantify the cost benefits which can accrue to the various modes through containerization. A beginning has been made in test runs which have demonstrated significant reductions in power requirements for COFC as compared to TOFC piggyback trains. A schedule needs to be developed to show the increased income derived from stepwise improvements in the time that rolling stock is in revenue service. Such a schedule could be used to justify investments in container handling equipment to reduce turnaround time of trains in the freight yards. Simulations of freight movements by over-the-road trailer, TOFC piggyback, or COFC transfer could be developed to indicate optimum trip distance for each choice.

Benefits are claimed for freight users through greater use of containers. Examples of claimed benefits which need to be quantified in economic terms are reductions of in-transit inventories, improved damage and pilferage loss experience, and savings in packaging costs because the goods are not rehandled. If operating savings obtained by the carriers from handling containers are not sufficient to be passed on in direct rate reductions, then freight users will have to be sold on containerization because of the indirect benefits. Some of the freight user organizations with progressive physical distribution departments can be expected to develop economic analyses which will indicate whether or not to embrace containerization. However, the burden of responsibility for much of the economic research in the areas discussed falls to the rail carriers. In the long run they stand to be most concerned with investment decisions relating to containerization.

A unified systems approach to the national freight transportation problem is needed.[8] The concept of containerization appears to offer possible use as an integrating tool in the development of such a unified system. Economic analysis will be required to determine how the benefits of such an integration can best be distributed in order to encourage active participation by all the sectors. It may be that such a broad study would best be conducted by an impartial private research group or governmental agency.

Logistical Studies

Logistical studies encompass both economic and systems analysis considerations. Logistical studies are needed in order to optimize decisions in the implementation of containerized systems. Following are a few questions which serve as examples of the type of problems which need to be solved by such studies.

- How many sets of bogies are needed and where should they be inventoried to serve a given number of containers which are distributed to a given pattern of stations?
- What is the optimum size and layout of a container marshalling yard needed to serve a given projected traffic volume?

- What are the optimum equipment handling facilities for different sized operations?
- What are the best schedules which can be developed for dedicated train service on long hauls?
- Where are the existing and projected centers which will justify assignment as container handling hubs?

Railroads should take the responsibility for research in the logistical area since the problems relate more to their activities than to other modal sectors in domestic freight movements. Research sponsored by trade associations would help to use available funds more effectively by reducing overlapping effort.

Research on Equipment

Further research is needed in the design of the containers themselves and in the handling equipment to improve ease of intermodal transfers and to reduce costs. Different materials of construction need to be developed in order to reduce container tare weights, to make them more durable, and to reduce their cost. Experiments with different cubic arrangements can lead to greater compatibility between over-the-road piggyback, and marine modal requirements. Modifications to meet special needs will help to expand container use. Development of internal fittings which can be used to better secure the loads quickly and cheaply is one such area which can be pursued.

Experiments with mini-containers have been described in the literature. These are modular subunits of the standard sized containers which can be used for consolication of less-than-carload lots. They offer promise of savings to forwarders who may arrange to collect them pre-loaded from a circuit of customers and then stuff them readily into containers or truck vans for the long haul. Such mini-containers should also find use on the production line for consolidation of high value products which are shipped in less-than-carload lots.

The search for competitive advantage should motivate the equipment suppliers to promote research on equipment. Two examples of work in progress are the current development of light weight boxes for air shipment and the improved trailers for side-transfer loading of containers.

Coordination by Business

Coordination is the key to any real progress in domestic container activity. Cooperation among the carriers will have to improve in order to meet coordinative needs. Their work should be directed toward developing a better understanding of customer wants and of promoting programs designed to meet these wants. The container offers the promise of savings to the customer through more efficient rapid transfer of goods. Wasted motion of dead head traffic and terminal delays can be reduced by better coordination. If suppliers coordinate their efforts, leasing, equipment interchange agreements, and nationwide pool arrangements can provide ready access to containers when and where they are needed. Domestic and international pool requirements can be integrated for maximum effectiveness.

Rate structures need to be examined carefully in order to develop incentives for container usage and to provide for an equitable distribution of costs and benefits. Joint rates are indicated as desirable for freight movements involving intermodal transfers. The cost of transporting a box of a given size over a given distance containing a given weight cargo dictates the use of a freight-all-kinds (FAK) rate structure. The offer of unrestricted FAK rates will promote greater use of containers and will eliminate effort now wasted in examining cargos to check on commodity declarations. FAK rates will also reduce paperwork.

A workable means of distributing liability for losses from damage to goods and equipment is needed. A program should be developed for frequently inspecting and properly maintaining containers. A nationwide tracing and accounting procedure is needed to assign per diem charges and to discourage under-utilization of the equipment. Automated methods which have already been developed for identification of containers en route should be implemented.

Some business firms now recognize that their physical distribution needs go beyond the historical rate and scheduling work of the traffic department. Effective physical distribution management can contribute significantly to corporate profits. The container can prove to be a useful tool for those distribution managers who have been educated to its potential. The equipment suppliers and carriers can contribute to the education of customers in the use of containers and intermodalism. The trade associations are logical candidates for promoting desired educational programs among their members.

Coordination by Government

Many businessmen prefer a "hands-off" situation in freight activities as far as government is concerned. However, the regulatory agencies need to move beyond day-to-day regulation as their almost exclusive function and to encompass responsibility for promoting longer range developments in the transport industry. The layers of lawyers need to be supplemented with people who are competent in transport technology. Governmental nudging may prove to be effective in promoting intermodal cooperation. An example of such service is the present program by the Department of Transportation to develop a common equipment interchange agreement. Success in simplification of documentation and customs requirements can only be achieved through cooperative efforts of government and business.

Rate regulation needs to be directed toward promoting overall efficiency in the national transport system rather than toward protectionism and maintenance of the status quo. Joint rates should be encouraged if they promote efficiency and equitable distribution of revenues. Forwarders should be allowed more flexibility in setting rates if they can thereby help to minimize the small shipments problem. Growth of freight brokerage organizations should be encouraged if such a development is determined to be beneficial to greater transport efficiency.

The limitations of regulation by three major agencies have long been recognized and pressure is growing for consolidation of their activities. Fragmented regulation has impeded through service arrangements for container movements. Coordination of containerization in the national transport structure would be more effective if the regulatory agencies themselves were better coordinated. As an example, guidance from a single transport agency could be expected to promote equipment standards more suitable to both domestic and marine modal requirements.

Research and development work which is aimed at optimizing development of the national transport system can best be guided by an organization which has an overall perspective. The Department of Transportation has developmental responsibility included in its charter. The Department could encourage cooperation between trade organizations in promoting containerization and other innovations which will improve transport efficiency. Research projects can be underwritten to standardize paperwork, to develop simulations aimed at economic and logistic evaluations of container movements, and to project future transport requirements. The desirability of combining both developmental and transport regulation into a single authority should be assessed by an unbiased study.

Final Note

The entrepreneurship of Malcolm McLean is credited with the giving birth to the explosive growth of containers in marine service. Others can be expected to foster ideas which will bring the full benefits of containerization to the domestic freight sector. One writer predicts that there will be more containers than rail cars in service by the year 2000.[9] Innovations in automated handling and storage of containers have already been proposed.[10] The container will be an important link in an integrated national freight transport system of the future. The people who pay the freight bills will demand the savings that containers can provide.

CHAPTER VI--FOOTNOTES

[1]"Development of the Questionnaire," Chapter IV, p. 163.

[2]Table 28-B. "Within Group Mean Values for Test of Hypothesis 1-A," p. 196.

[3]*Ibid.*

[4]See Table 26, p. 193.

[5]See Table 27, p. 194.

[6]See Table 34, p. 214.

[7]See Table 36, p. 218.

[8]For a treatment of the systems approach to physical distribution, see D. J. Bowersox, E. W. Smykay, and B. J. Lalonde, *Physical Distribution Management* (New York: The Macmillan Co., 1968). Especially see Chapter 12, "Distribution System Design," pp. 323-351.

[9]Vincent F. Caputo, "Transportation in the Year 2000," in *Transportation and Tomorrow*, ed. by K. M. Ruppenthal and H. A. McKinnell, Jr. (Stanford, California: Stanford University Graduate School of Business, 1966), p. 23.

[10]*Ibid.*, Kenneth L. Vore, "A Shipper Views Tomorrow's Transport," pp. 156-160.

BIBLIOGRAPHY

BIBLIOGRAPHY

Books

Bowersox, D. J., Smykay, E. W., and LaLande, B. J. Physical Distribution Management. New York: The Macmillan Co., 1968.

Chao, L. L. Statistics: Methods and Analyses. New York: McGraw-Hill Book Co., 1969.

Colton, R. E., and Ward, E. S. Practical Handbook of Industrial Traffic Management. Washington, D.C.: The Traffic Service Corp., 1965.

Church, Robert F. Background Note on the Development of Containerized International Shipping. Evanston, Illinois: Transportation Center at Northwestern University, 1968.

Clark, Charles T., and Schkade, L. L. Statistical Methods for Business Decisions. Cincinnati: South-Western Publishing Company, 1969.

Erdos, Paul L., and Morgan, A. J. Professional Mail Surveys. New York: McGraw-Hill Book Co., 1970.

Ferber, Robert, Blankertz, D. F., and Hollander, Sidney, Jr. Marketing Research. New York: The Ronald Press Co., 1964.

________, and Verdoorn, P. J. Research Methods in Economics and Business. New York: The Macmillan Co., 1970.

Finlay, Patrick, ed. Jane's Freight Containers. New York: McGraw-Hill Book Co., 1969.

Friedlander, Ann F. The Dilemma of Freight Transport Regulation. Washington, D.C.: The Brookings Institute, 1969.

Guilford, J. P. Psychometric Methods. New York: McGraw-Hill Book Company, 1954.

Kerlinger, Fred N. Foundations of Behavioral Research. New York: Holt, Rinehart and Winston, Inc., 1964.

Kirk, Roger E. Experimental Design: Procedures for the Behavioral Sciences. Belmont, California: Brooks/Cole Publishing Company, 1968.

Luck, David J., Wales, H. G., and Taylor, Donald A. Marketing Research. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1970.

Magee, John F. Industrial Logistics--Analysis and Management of Physical Supply and Distribution Systems. New York: McGraw-Hill Book Co., 1968.

Morrison, Donald F. Multivariate Statistical Methods. New York: McGraw-Hill Book Co., 1967.

Osgood, Charles E., Suci, G. J., and Tannenbaum, P. H. The Measurement of Meaning. Urbana, Illinois: The University of Illinois Press, 1957.

Pegrum, Dudley F. Transportation: Economics and Public Policy. Homewood, Illinois: Richard D. Irwin, Inc., 1963.

Selby, Samuel M., ed. Standard Mathematical Tables. Cleveland: The Chemical Rubber Co., 1967.

Siegel, Sidney. Nonparametric Statistics for the Behavioral Sciences. New York: McGraw-Hill Book Co., 1956.

Sims, Ralph E. Planning and Managing Material Flow. Boston: Industrial Education Institute, 1968.

Tabak, Herman D. Cargo Containers--Their Stowage, Handling, and Movement. Cambridge, Maryland: Cornell Maritime Press, 1970.

Taff, Charles A. Management of Traffic and Physical Distribution. Homewood, Illinois: Richard D. Irwin Co., 1964.

Dunn and Bradstreet. Reference Book of Transportation--Spring, 1970. Washington, D.C.: Trinc Transportation Consultants, 1970.

Inland and Maritime Transportation of Unitized Cargo. Washington, D.C.: National Academy of Sciences, 1963.

Moody's Industrial Manual--July, 1969. New York: Moody's Investor's Service, 1969.

Moody's Transportation--March, 1970. New York: Moody's Investor's Service, 1970.

The Official Directory of Commercial Traffic Executives. Washington, D.C.: The Traffic Service Corp., 1969.

Articles in Books

Forgash, Morris. "Containerization--A Tool of Transportation," Transportation Century. Edited by George F. Mott. Baton Rouge, Louisiana: Louisiana State University Press, 1966.

Caputo, Vincent F. "Transportation in the Year 2000," pp. 18-23.
Vore, Kenneth L. "A Shipper Views Tomorrow's Transport," pp. 156-160. Transportation and Tomorrow. Edited by K. M. Ruppenthal and H. A. McKinnel, Jr. Stanford, California: Stanford University Graduate School of Business, 1966.

Bayer, Palmer. "Pool Systems and Coordination," pp. 195-200.
Dircx, C. P. "Inter- and Intramodal Coordination on the Missouri Pacific," pp. 183-191.
Hulse, John B. "Standards and Specifications in Coordination," pp. 222-227.
Mazure, James E. "Reducing Overlap Barriers in Ocean Commerce," pp. 103-107.
Muller, Fred, Jr. "The Role of Standards in International Coordination," pp. 216-222. Coordinated Transportation. Edited by E. G. Plowman. Cambridge, Maryland: Cornell Maritime Press, Inc., 1969.

Periodicals

Becker, H. G., Jr. "The First Domestic Container Program," Handling and Shipping, July, 1970, pp. 45-46.

Behling, Burton N. "1969 Review," Railway Age, January 19, 1970, pp. 54-67.

Blackwell, R. J. "Perspective on Through Routes and Rates," Brandon's Container World, May, 1970, pp. 27-28.

Dillon, Thomas F. "Containerization--A New Twist on an Old Idea," Purchasing, January 28, 1962, pp. 84-86ff.

Dixon, James M. "Truckers Outlook Is 'Mixed Bag,'" Distribution Worldwide, April, 1970, pp. 36-38.

Elson, Joel. "Pilferers, Hijackers Confound All Parties," Metalworking News, May 4, 1970, Sec. 2, p. 20.

Hilts, R. G. The Official Intermodal Equipment Register--Containers, Chassis and Bogies in Intermodal Service. New York: Intermodal Publishing Co., Ltd., Vol. 2, No. 1, August 15, 1970.

Howell, R. E. "Growth and Problems of Containerization," Distribution Worldwide, September, 1970, pp. 37-41.

Marshall, Kenneth. "New Routes for World Trade?" Transportation and Distribution Management, October, 1969, pp. 60-64.

Nagle, Richard T. "Roll On-Roll Off: Piggyback Goes to Sea," Railway Age, October 27, 1969, pp. 46-47.

Salzano, Carlo J. "Government, Industry Spokesmen Express Divergent Views on Intermodal Transport," Traffic World, March 14, 1970, pp. 21-25ff.

Schirmer, W. E. "Integrated Physical Distribution--A Container Must," Brandon's Container World, May, 1970, pp. 9-12.

Welty, Gus. "TOFC/COFC: Why the Future Looks So Good," Railway Age, May 29, 1967, pp. 29-36.

________. "Tomorrow's Railroads," Railway Age, August 25, 1969, pp. 33-40.

"Another Round of ILA vs. NYSA," Brandon's Container World, May, 1970, p. 4.

"Transport in the 70's: Revolution Ahead," Business Management, November, 1969 (Reprint).

"Trans-Atlantic Containerization . . . Circa 1901," Distribution Age, February, 1967, p. 36.

"The Ultimate Unit Train?--Support for 'Land Bridge' Grows," Distribution Manager, May, 1968, pp. 44-45.

"Container Potential Up," Distribution Manager, June, 1968, p. 28.

"Export Is the Name of the Game," Distribution Manager, June, 1968, pp. 36-37.

"The Port Terminals--A New and Expanded Role," Distribution Manager, October, 1968, pp. 52-56.

"Insurance Yardsticks for Export Containers," Distribution Manager, June, 1968, pp. 53-58.

"Ton Mile Distribution Among Intercity Freight Carriers," Distribution Manager, April, 1969, p. 24.

"New York Port Balks," Distribution Worldwide, February, 1970, pp. 14-15.

"Big Boxing Event," Distribution Worldwide, April, 1970, p. 59.

"Leased-Container Surge," Distribution Worldwide, April, 1970, p. 33.

"Unit Load Council Set," Distribution Worldwide, May, 1970, p. 26.

"Containerization's Changing Patterns--How Fleets Fit In," Fleet Owner, January, 1961, pp. 66-70.

"The Fortune Directory of the 500 Largest Corporations," Fortune, May 15, 1969, pp. 166-184.

"The Fortune Directory of the Second 500 Largest Corporations," Fortune, June, 1970, pp. 98-125.

"1970 Routing and Transportation Information Directory," Handling and Shipping, February, 1970, pp. 41-49.

"Shrink Film Palletizing: It's Everybody's Baby, Now," Material Handling Engineering, February, 1970, pp. 69-81.

"The Container and the User," Mechanical Handling, October, 1969, pp. 108-110.

"Shrink-Wrapping of Pallet Loads to Grow," Package Engineering, May, 1970, p. 32.

"For Trailer/Container Builders: Market Boom in TOFC," Railway Age, August 26, 1963, pp. 19-27.

"'Super C', Santa Fe Claims It Has World's Fastest Freight Train," Railway Age, January 29, 1968, pp. 22-25.

"Will Labor Help the Railroads Carry the Freight?" Railway Age, March 4, 1968, p. 40.

"We Need a Meeting of Minds on Common Goals," Railway Age, June 2, 1969, pp. 20-23.

"1970 Outlook-Carmarket: 70,000 in '70," Railway Age, January 19, 1970, pp. 33-38ff.

"White House Cool on Agency Merger Plan; Senators Call for End of ICC," Traffic Management--Physical Distribution, September, 1970, p. 11.

"Consulting Engineer Believes Containers Will Replace Trailers in Piggyback Service," Traffic World, October 31, 1959, pp. 42-43.

"Hearings Opened by House Panel on Bill to Permit Rail-Forwarder Rate Making," Traffic World, January 31, 1970, pp. 17-21.

"FMC Issues Rule Requiring Water Carriers to File Through, Joint Intermodal Rates," Traffic World, April 18, 1970, pp. 79-80.

"Independent Ownership of Modes Not Found to Be Hindering Containerization," Traffic World, April 18, 1970, pp. 27-29.

"ICC Urges Enactment of Routes-Rates Measure as Senate Hearings Begin," Traffic World, May 9, 1970, pp. 86-88.

"ICC Must Choose Between Marginal-Cost or Full-Cost Standard in Setting Rates," Traffic World, May 23, 1970, pp. 68-69.

"International Container Pool," Transportation and Distribution Management, January, 1969, p. 12.

"Joint Rates," Transportation and Distribution Management, June, 1970, p. 19.

"Nader Group Says ICC Fail Public, Urges Single Transportation Regulatory Agency," Wall Street Journal, March 17, 1970, p. 6:3.

"Inter-Freight--The Only Distribution System that Assumes Total Liability," (Advertisement), Wall Street Journal, July 7, 1970, p. 11.

"Freuhauf Sees 33% Fall in Trailer Industry's Volume During 1970," Wall Street Journal, August 31, 1970, p. 15:3.

Public Documents

U.S. Department of Commerce. Office of Business Economics. 1969 Business Statistics. Washington, D.C.: Government Printing Office, 1970.

U.S. Department of Commerce. Maritime Administration. Foreign Oceanborne Trade of the United States--Containerized Cargo--Selected Trade Routes--Third Quarter, 1969, 1969.

U.S. Department of Commerce. Maritime Administration. U.S. Flag Containerships and U.S. Flag Ships with Partial Capacities for Containers--As of June 30, 1969, 1969.

U.S. Department of Commerce. Maritime Administration. Automatic Container Identification Conference. Washington, D.C.: Government Printing Office, 1970.

U.S. Congress. Senate. National Transportation Policy. John P. Doyle, Staff Director. Report of the Committee on Commerce, Special Study Group on Transportation. Report No. 445, 87th Congress, 1st Session, June 26, 1961.

U.S. Congress. Senate. Seminars on the Container Revolution. Prepared for use of the Committee on Commerce. Washington, D.C.: Government Printing Office, 1968.

U.S. Department of Defense. Military Standard--Palletized and Containerized Unit Loads. MIL-STD-147B, 1968.

U.S. Interstate Commerce Commission. 173 ICC 377, April 14, 1931, ICC Docket No. 21723, In the Matter of Container Service. ICC Reports Vol. 173, March-April, 1931. Washington, D.C.: Government Printing Office, 1931, pp. 377-450.

U.S. Interstate Commerce Commission. 216 ICC 435, June 20, 1936, Trucks on Flatcars Between Chicago and Twin Cities. ICC Reports Vol. 216. Washington, D.C.: Government Printing Office, 1936.

U.S. Interstate Commerce Commission. 232 ICC 683, July 25, 1939, ICC Decision: Ex Parte No. 129, Substituted Freight Service. ICC Reports Vol. 232, March-July, 1939. Washington, D.C.: Government Printing Office, 1939, pp. 683-693.

U.S. Interstate Commerce Commission. 293 ICC 93, July 30, 1954, ICC Docket No. 31375, Movement of Highway Trailers by Rail. ICC Reports Vol. 293, June, 1954-January, 1955. Washington, D.C.: Government Printing Office, 1955, pp. 93-112.

U.S. Interstate Commerce Commission. 322 ICC 301, March 16, 1964, Ex Parte 230, Substituted Service--Charges and Practices of For-Hire Carriers and Freight Forwarders (Piggyback Service). Decisions of the ICC of the U.S. Vol. 322, January, 1964-July, 1964. Washington, D.C.: Government Printing Office, 1966, pp. 301-417.

U.S. Interstate Commerce Commission. Bureau of Accounts. Cost of Transporting Freight by Class I and Class II Motor Common Carriers of General Commodities--Transcontinental Territory--1966. Washington, D.C.: Government Printing Office, 1968.

U.S. Interstate Commerce Commission. Bureau of Economics. Piggyback Traffic Characteristics. Washington, D.C.: Government Printing Office, 1966.

U.S. Interstate Commerce Commission. Bureau of Accounts. Transport Statistics of the United States, 1966--Part 8: Freight Forwarders. Washington, D.C.: Government Printing Office, 1967.

U.S. Interstate Commerce Commission. 82nd Annual Report of the Interstate Commerce Commission--Fiscal Year Ended June 30, 1968. Washington, D.C.: Government Printing Office, 1968.

U.S. Interstate Commerce Commission. In the Public Interest-1970. Washington, D.C.: Government Printing Office, 1970.

U.S. Interstate Commerce Commission. Bureau of Economics. Transport Economics. July, 1969, April, 1970.

U.S. Department of Transportation. United States Department of Transportation. Washington, D.C.: Government Printing Office, 1969.

Reports

Guide for the Certification of Cargo Containers. New York: American Bureau of Shipping, 1969.

Yearbook of Railroad Facts. Washington, D.C.: Association of American Railroads, 1968.

IATA Bulk Unitization Concept. Montreal: International Air Transport Association, 1969.

Containerization--An Outlook to 1977. Oakland, California: Technical Publications Department, Kaiser Aluminum and Chemical Corp., 1968.

Ayre, Josephine. "History and Regulation of Trailer-on-Flatcar Movement," Highway Research Record, No. 153--Piggyback--5 Reports. Washington, D.C.: Highway Research Board, National Academy of Sciences, 1967, pp. 1-30.

Hammond, Robert A. "Emerging Changes in the Container Revolution," Highway Research Record, No. 281--Use of Containerization in Freight Transportation. Washington, D.C.: Highway Research Board, National Academy of Sciences, 1969, pp. 10-15.

Litton Systems, Inc. Oceanborne Shipping: Demand and Technology Forecast--Part 2. Washington, D.C.: Government Printing Office, 1968.

An Economic Study of Containerization and Its Markets. Richmond, Virginia: Market Research Department, Reynolds Metals Co., 1961.

Roberts, Merrill J. Intermodal Freight Transportation Coordination: Problems and Potential. Prepared for the Under Secretary of Transportation, U.S. Department of Commerce. Pittsburgh: University of Pittsburgh, 1966.

Annual Report--1969. Philadelphia: Trailer Train Co., 1970.

The Trailer Train Story. Philadelphia: Trailer Train Co., 1970.

Containerization--A Maturing Intermodal Concept. Pittsburgh: United States Steel Co., 1969.

XTRA Directory. Boston: XTRA, Inc., 1970.

Proceedings

Barloon, Marvin J. "Containers--Economics and Impact," Regular Common Carrier Conference Report on Containerization in International and Domestic Traffic. Washington, D.C.: American Trucking Assn., 1969, pp. 1-7.

Maritime Cargo Transportation Conference. Inland and Maritime Transportation of Unitized Cargo. Washington, D.C.: National Academy of Science, 1963.

U.S. Department of Defense. Conatinerization Usage Briefing for National Defense Transportation Association. Washington, D.C.: National Defense Transportation Association, 1968.

Cripe, Alan R. "Containerization and Integral Trains," Integral Trains. Chicago: Railway Systems and Management Association, 1963, pp. 13-22.

Owen, R. J., Proff, R. A., and King, P. J. "Research and the Unit Load Principle," TOFC and Containerization. Chicago: Railway Systems and Management Association, 1963, pp. 50-59.

Muller, Fred, Jr. "The Impact of Container Standards on Integrated Transportation," pp. 29-34.

Stenason, W. J. "Multi-Modal Ownership in Transportation," pp. 469-475. Papers--Eighth Annual Meeting--Transportation Research Forum. Oxford, Indiana: Richard B. Cross Co., 1967.

Containerization--Problems of Today and Potential for Tomorrow. (Panel Discussion) Truck Trailer Manufacturers Association. 26th Annual Convention, Grand Bahama Islands, BWI. Washington, D.C.: Truck Trailer Manufacturers Assn., 1967.

Unpublished Material

Autenrieth, Robert H. Statement Before the Containerization Institute Conference. (Mimeograph.) Los Angeles, California, November 13, 1969.

Besson, Frank S., Jr. Defense Implications of Containerization. (Mimeograph.) Talk before the Containerization Exposition, April, 1970.

Birchler, Eugene R. Six Myths About Containerization. (Mimeograph.) Talk before the International Executives Association. New York City, February, 1969.

________. Containerization--The Inevitable. (Mimeograph.) Speech before the First Annual International Marketing Seminar on Trends and Developments in Physical Distribution. Sutton, Massachusetts, June, 1969.

Bowersox, Donald J. The Economics of Containerization in Physical Distribution. (Mimeograph.) Talk before the Containerization Institute--Tenth Annual Conference. New York City, January, 1970.

Bridges, H. Containers and Their Effect on Waterfront Workers. (Mimeograph.) Talk presented before the Fall Meeting of the Containerization Institute. Los Angeles, California, November 13, 1969.

Bayliss, Arthur E. The Through Bill of Lading and Joint Rates. (Mimeograph.) Presented to the Technical Congress and Exposition. New York Coliseum, September 17, 1969.

________. International Documentation--Where Are We Now? (Mimeograph.) Talk Before the Containerization Institute Tenth Annual Conference. New York, January, 1970.

________. The Documentation Dilemma--Let's Solve It Now. (Mimeograph.) For the International Transportation Seminar. University of Hawaii, Honolulu, Hawaii. New York: National Committee on International Trade Documentation, 1970.

Gibson, A. E. Land Bridge--Fact or Fiction? (Mimeograph.) Remarks Before National Railroad Piggyback Association. Montreal, Canada, July 23, 1969.

Gleason, Thomas W. The Automation Problems Are Coming. (Mimeograph.) Address before the Fifth International Container Services and Equipment Exposition. Chicago, Illinois, April, 1970.

Hale, Bernard J. Containerization--A Vital Part of the Mattel Success Story. (Mimeograph.) Speech at the Fifth International Container Services and Equipment Exposition. Chicago, Illinois, April, 1970.

Hammond, H. F. Containerization--The Labor-Management Viewpoint. (Mimeograph.) Talk presented before the Fall Meeting of the Containerization Institute. Los Angeles, California, November 13, 1969.

Holdridge, A. R. Technical Report No. 12: Four Dimensional Contingency Tables--NUCROS. (Mimeograph.) East Lansing, Michigan: Computer Institute for Social Science Research, Michigan State University, February, 1968.

Porton, O. I. M. A Look at Labor and Containers in Europe. (Mimeograph.) Talk before the Fifth International Container Services and Equipment Exposition. Chicago, Illinois, April, 1970.

Wright, D. J. Jeremy D. Finn's Multivariance--Univariate and Multivariate Analysis of Variance and Covariance; A FORTRAN IV Program. (Mimeograph.) Occasional Paper No. 8. East Lansing, Michigan: Office of Research Consultation, College of Education, Michigan State University, 1970.

Walrath, L. K. (ICC Commissioner.) Remarks Before the National Conference of State Transportation Specialists. (Mimeograph.) Seattle, Washington, May 8, 1968.

________. Remarks Before the Association of Interstate Commerce Commission Practitioners. (Mimeograph.) Minneapolis, Minnesota, June 21, 1968.

Bibliographies

Jamison, Paul E. A Bibliography of Research Papers in Transportation, Traffic and Distribution Management. Washington, D.C.: The Traffic Service Corp., 1968.

Ramm, Dorothy V. A Bibliography on Economics of Containerization. Evanston, Illinois: The Library of the Transportation Center at Northwestern University, 1968.

Current Literature in Traffic and Transportation. (Monthly.) Evanston, Illinois: The Library of the Transportation Center at Northwestern University.

Containers--A List of References--1901-1968. Washington, D.C.: Economics and Finance Department Library, Association of American Railroads, 1969.

Containerization in Global and Domestic Goods Transport. Bulletin of the Business Information and Science and Technology Departments. Cleveland: Cleveland Public Library, July, 1967.

APPENDICES

APPENDIX A

INSTRUMENTS USED FOR COLLECTING DATA

MICHIGAN STATE UNIVERSITY EAST LANSING · MICHIGAN 48823

GRADUATE SCHOOL OF BUSINESS ADMINISTRATION

DEPARTMENT OF MARKETING AND TRANSPORTATION ADMINISTRATION · EPPLEY CENTER

July 21, 1970

I am a graduate student working on a doctoral degree in Marketing and Transportation Administration. My research project involves an analysis of the factors which are retarding growth of containerization in domestic surface freight shipments. The enclosed short multiple-choice questionnaire has been directed to experienced businessmen in order to obtain a meaningful cross section of opinion in the study.

The questions are nonproprietary in nature. Identity of the survey participant is not shown on the form and all correspondence will remain confidential. A sheet is provided which can be returned with the questionnaire or separately if you desire a report on the results of the study.

Response from you or another qualified member of your firm is important to my ability to make this research project meaningful. A stamped, addressed return envelope is provided for your convenience. I want to thank you for taking the time to complete the form and return it.

Very truly yours,

Vernon C. Seguin
Doctoral Candidate

MICHIGAN STATE UNIVERSITY EAST LANSING • MICHIGAN 48823

GRADUATE SCHOOL OF BUSINESS ADMINISTRATION

DEPARTMENT OF MARKETING AND TRANSPORTATION ADMINISTRATION • EPPLEY CENTER

August 4, 1970

Recently I mailed you a short questionnaire relating to my research on containerization in domestic surface freight shipments. Since these were sent to men like yourself in a number of different business categories, your opinion is very important to the accuracy of my doctoral degree study.

Since the previous mailing was conducted so that your answers would be anonymous, it is possible that you have already sent in your reply. In this case let me take this opportunity to thank you again.

In case my original request didn't reach you, I have provided another copy of the short multiple-choice form. It should only take a few minutes for you or another qualified member of your firm to fill out and return it in the enclosed stamped envelope. A sheet is also provided which can be returned with the questionnaire or separately if you desire a report on the results of the study.

Even if you feel that only part of the questions apply to your business, your reply will still be valuable if not completely filled out. Many thanks for your help in my study.

Very truly yours,

Vernon C. Seguin
Doctoral Candidate

MICHIGAN STATE UNIVERSITY
DEPARTMENT OF MARKETING AND
TRANSPORTATION ADMINISTRATION

CONTAINERIZATION is defined as the integration of commodities into common denominator large metal, wood, or plastic boxes, such as the standard-sized 8' x 8' x 20' or similar boxes designed for intermodal transfers. Please indicate your estimate of the relative importance of each FACTOR listed below in retarding growth of containerization in domestic surface shipments. Where the factors considered may not relate directly to your experience, use your best judgment in order to answer as many questions as possible. The degree of importance choice has been scaled as follows:

1. Extremely Important
2. Quite Important
3. Medium Importance
4. Not Very Important
5. Almost No Importance

Circle your choice 1 2 3 4 5

RELATIVE IMPORTANCE OF FACTORS RETARDING
DOMESTIC SURFACE CONTAINERIZATION

1. NONSTANDARD CONTAINERS
The existence of nonstandard containers inhibits intermodal transfers 1 2 3 4 5

2. INVESTMENT REQUIREMENTS
Adoption of containerization requires a capital investment decision. 1 2 3 4 5

3. DISTRIBUTION OF BENEFITS
Benefits from containerization may not be distributed proportionately to respective participants' investments. 1 2 3 4 5

4. DIVIDED CARRIER RESPONSIBILITY
Responsibility for coordination of intermodal freight movements is divided among the carriers involved. 1 2 3 4 5

5. LACK OF LAND BRIDGE
An effective coast-to-coast rail container land bridge has not yet been developed. 1 2 3 4 5

1. Extremely Important
2. Quite Important
3. Medium Importance
4. Not Very Important
5. Almost No Importance

RELATIVE IMPORTANCE OF FACTORS RETARDING DOMESTIC SURFACE CONTAINERIZATION

6. INTERMODAL OWNERSHIP FORBIDDEN
Present laws and regulations prevent common ownership or control of modes. 1 2 3 4 5

7. INADEQUATE CONTAINER INTERCHANGE
An effective national container pool system does not exist. 1 2 3 4 5

8. CONTAINER AND CHASSIS SHORTAGES
Shortages of containers or chassis/ bogey rigs result in shipment delays. 1 2 3 4 5

9. TERMINAL HOLDUPS
Rail or truck terminal holdups cause undesirable shipment delays. 1 2 3 4 5

10. TOFC ALTERNATIVE
TOFC (Trailer on Flatcar) piggyback service provides an acceptable alternative to containerized shipments. 1 2 3 4 5

11. EXISTING TOFC INVESTMENTS
Containerization may not offer sufficient economic incentive for switching to those who are heavily invested in TOFC piggyback facilities. 1 2 3 4 5

12. LACK OF GOVERNMENT LEADERSHIP
Government has supplied little leadership in promoting containerized intermodal traffic. 1 2 3 4 5

13. GOVERNMENTAL REGULATION
Governmental regulations and agency jurisdictional overlaps retard containerization developments. 1 2 3 4 5

14. INADEQUATE RATE STRUCTURES
Through shipment rate structures are needed to encourage a shift to containerization. 1 2 3 4 5

15. EMPTY CONTAINER TRAFFIC AND TARIFFS
Unbalanced traffic and nonstandard empty container rates contribute to "dead head" movement costs. 1 2 3 4 5

1. Extremely Important
2. Quite Important
3. Medium Importance
4. Not Very Important
5. Almost No Importance

RELATIVE IMPORTANCE OF FACTORS RETARDING DOMESTIC SURFACE CONTAINERIZATION

16.	<u>LACK OF MOTOR CARRIER SUPPORT</u> Many truckers believe that expanded containerization would reduce less-than-truckload and long haul revenues.	1	2	3	4	5
17.	<u>SHIPLINE LEADERSHIP</u> Shiplines have taken major responsibility for promoting containerization without giving adequate consideration to domestic sector needs.	1	2	3	4	5
18.	<u>LABOR RESISTANCE</u> Threat of loss of jobs encourages the labor movement to impede containerization.	1	2	3	4	5
19.	<u>INEFFICIENT CONTAINER CUBE vs VANS</u> Trailer vans offer more efficient cubic volume per trip in over-the-road trips than standard containers.	1	2	3	4	5
20.	<u>INTERMODAL RIVALRY</u> No carrier sells intermodal operations; each one tries to sell his own mode.	1	2	3	4	5

The remaining questions, which pertain to your firm, are nonconfidential in nature and will be used only for classification of the above questionnaire replies. Please turn to the last page.

A. Check below which category most closely represents your firm's viewpoing in answering a freight questionnaire.

USER: Shipper_____ Consignee_____ Forwarder_____

CARRIER: Motor_____ Rail_____ Marine_____ Air_____

CONTAINER EQUIPMENT SUPPLIER_____ OTHER--Specify___________

B. If you checked a USER category in Question A above, please answer the remaining questions. All others may proceed to the loose sheet enclosed to offer any additional comments and to request a report on the results of the questionnaire.

1. Does your firm ship or receive trailer-on-flatcar (TOFC piggyback) freight in domestic trade? Yes___ No___

2. Does your firm ship or receive containerized freight in domestic trade? Yes___ No___

3. Does your firm ship or receive containerized freight in foreign trade? Yes___ No___

4. If your firm does ship or receive containerized freight, do you own most or all of the containers you use? Yes___ No___

5. Regardless of your freight practices, are some of your goods deemed containerizable? Yes___ No___

6. Please check the most appropriate annual gross sales bracket for your firm:
   Over $200 million _____ $1 to $9 million _____
   $50 to $200 million _____ Less than $1 million _____
   $10 to $49 million _____

7. Check your major classification (FORWARDERS skip this).

   DURABLE GOODS MANUFACTURE_____(Machinery, transport equipment, primary metals, wood, furniture, glass, fabricated products, etc.)

   NONDURABLE GOODS MANUFACTURE_____(Food, beverage, tobacco, drugs, textiles, apparel, paper, publishing, chemicals, petroleum, etc.)

   RETAILER_____ OTHER--Specify_______________

If you desire to receive a summary of the questionnaire results, please fill in your address below and return it.

NAME_______________________________________

TITLE______________________________________

ORGANIZATION_______________________________

ADDRESS____________________________________

____

Zip__________________

If there are any factors which have not been covered in the questionnaire which you feel are important in inhibiting growth of containerization in domestic surface movements, or if you have any additional comments to offer, please note them on the remainder of this sheet. Your assistance in filling out the questionnaire is greatly appreciated. Thank you.

COMMENTS:

INTERVIEW OUTLINE

FACTORS INHIBITING GROWTH OF DOMESTIC SURFACE CONTAINERIZATION

The purpose of this interview is to help develop a number of recommended actions to be taken to promote domestic containerization, in line with findings of the questionnaire you have been shown. It has been completed by about 300 men representing freight users, carriers, and containerization equipment suppliers.

About 98 percent of the freight users claimed that some or all of their goods was containerizable, but only about 40 percent stated they shipped or received containerized freight in domestic shipments. All respondent sectors listed the lack of adequate shipment rate structures among the top factors limiting development of domestic surface containerization. Would you comment on the limitations of present rate structures and do you have any suggestions as to how they might be adjusted to promote containerization?

1.

Cost of "dead head" movements and nonstandard empty container rates are also at the top of the list as problems in the development of domestic containerization. Are you aware of any actions being taken and do you have any suggestions to relieve this problem?

2.

Is labor resistance to containerization going to be a long-term problem in the domestic freight area? Are there any encouraging developments in this matter?

3.

Nonstandard containers seem to be viewed as a major problem by all but the equipment suppliers. How may this situation be relieved as an impediment to growth of containerization in domestic shipments?

4.

Respondents believe that lack of an adequate national container pool is an important limitation to container movements. Do you feel that this problem will be overcome; if so, how will it be accomplished and how long would you expect it to take?

5.

The situation where responsibility for coordination of intermodal movements is divided among the carriers involved is viewed as an important factor, primarily by the carriers. Do you have any suggestions as to how this arrangement might be improved?

6.

There is some agreement among the carriers and equipment suppliers that shipline leadership in developing and promoting containerization has caused some of the problems in the domestic freight area. Do you believe there will be a shift in responsibility for development to the domestic carriers; if not, how can this problem be reduced?

7.

For the most part, governmental regulation and the lack of government leadership in developing domestic containerization are not considered serious factors. Is there likely to be any change in the role of government in this area of freight activity? What might governmental agencies do to help in development of domestic containerization?

8.

After looking over the factors included in the questionnaire, do you have any additional suggestions on changes which might be made to aid in development of domestic containerization? Are there any additional factors which have not been discussed which are important to the problem?

9.

INTERVIEWEE____

TITLE____

FIRM____

ADDRESS____

____

DATE______________________

APPENDIX B

OUTPUT SHEETS FROM COMPUTER RUNS

AND GLOSSARY OF TERMS

Table 41. Mean values used to test Hypothesis 1-A,B

FINN'S MULTIVARIANCE ANALYSIS PROGRAM • EDUCATION COLLEGE CONTAINERIZATION QUESTIONNAIRE • ANALYSIS OF 3 GROUPS

PAGE 4

CELL MEANS --- ROWS ARE CELLS COLUMNS ARE VARIABLES

	1 NONSTD	2 INVSMT	3 BENFTS	4 RESPBY	5 BRIDGE	6 IMOWNR	7 INTRCG	8 SHORTS	9 HOLDUP	10 TOFCAL
1	2,034014	2,374150	2,503401	2,367347	3,102041	2,605442	2,095238	2,265306	2,462585	2,285714
2	2,145833	2,114583	2,416667	2.229167	3,552083	2,791667	2,229167	2,625000	2,781250	2,760417
3	2,436364	2.272727	2,581818	2.400000	3,345455	2,763636	2,381818	2,636364	2,581818	2,690909

	11 TOFCIN	12 GOVLDR	13 GOVRGL	14 RATSTR	15 DEDHDS	16 MTRSPT	17 SHPLDR	18 LABORR	19 LOCUBE	20 RIVLRY
1	2,197279	3,047619	2,571429	1,857143	1,904762	2,761905	2,435374	1,857143	2,367347	2,306122
2	2,541667	3,020833	2,656250	1.791667	1,677083	2,770833	2,270833	2,093750	2,385417	2,468750
3	2,327273	2.981818	2,618182	1,890909	1,945455	2,581818	2,381818	2,127273	3,072727	2,454545

1 = Freight User

2 = Carrier

3 = Equipment Supplier

Table 42. Multivariate and univariate tests of Hypothesis 1-B

F-RATIO FOR MULTIVARIATE TEST OF EQUALITY OF MEAN VECTORS= 1.8094

D.F.= 40 AND 552.0000 P LESS THAN 0.0022

	VARIABLE	BETWEEN MEAN SQ	UNIVARIATE F	P LESS THAN	STEP DOWN F	P LESS THAN
1	NONSTD	3.2399	2.2419	0.1081	2.2419	0.1081
2	INVSMT	1.9564	1.4108	0.2456	1.7709	0.1720
3	BENFTS	0.5032	0.4478	0.6395	0.1438	0.8662
4	RESPBT	0.7251	0.5138	0.5988	0.2566	0.7739
5	BRIDGE	5.9777	3.8701	0.0220	4.5861	0.0110
6	IMOWNR	1.1676	0.7017	0.4966	0.2290	0.7956
7	INTRCG	1.7452	1.2068	0.3007	0.4182	0.6587
8	SHORTS	4.9323	3.3691	0.0358	2.2752	0.1047
9	HOLDUP	2.9496	2.0603	0.1293	1.0519	0.3507
10	TOFCAL	7.6056	5.2516	0.0058	5.2971	0.0056
11	TOFCIN	3.4447	2.5077	0.0832	0.8250	0.4393
12	GOVLDR	0.0892	0.0503	0.9510	0.4678	0.6269
13	GOVRGL	0.2128	0.1445	0.8656	0.0665	0.9358
14	RATSTR	0.2042	0.2000	0.8189	0.6361	0.5302
15	DEDHDS	1.8879	2.1380	0.1198	2.8750	0.0581
16	MTRSPT	0.7583	0.6266	0.5352	1.2520	0.2876
17	SHPLDR	0.7891	0.6359	0.5302	2.6344	0.0736
18	LABORR	2.3254	1.7488	0.1758	1.3043	0.2731
19	LOCURE	10.9424	7.1319	0.0010	6.4420	0.0019
20	RIVLRY	0.9269	0.7885	0.4555	0.6995	0.4978

DEGREES OF FREEDOM FOR HYPOTHESIS= 2
DEGREES OF FREEDOM FOR ERROR= 295

Table 43. Mean values used to test Hypotheses 2-A,B and 3-A,B

FINN'S MULTIVARIANCE ANALYSIS PROGRAM • EDUCATION COLLEGE CONTAINER QUESTIONNAIRE - 4 GROUPS; 2 SUBGROUPS

PAGE 4

CELL MEANS --- ROWS ARE CELLS COLUMNS ARE VARIABLES

	1 NONSTD	2 INVSMT	3 BENFTS	4 RESPBT	5 BRIDGE	6 IROWNR	7 INTRCG	8 SRORTS	9 HOLDUP	10 TOFCAL
1	2,206897	2,137931	2,413793	2,448276	3,137931	2,448276	2,206897	2,310345	2,448276	2,275862
2	1,863636	2,363636	2,686364	2,500000	3,000000	2,772727	1,909091	2,136364	2,181818	2,272727
3	1,666667	2,055556	2,500000	2,611111	3,611111	2,166667	2,055556	2,444444	2,833333	2,277778
4	2,166667	2,277778	2,500000	1,888889	3,222222	2,611111	1,611111	2,166667	2,166667	2,444444
5	1,857143	2,809524	2,666667	2,523810	3,095238	2,619048	2,047619	2,142857	2,428571	1,857143
6	2,333333	2,500000	2,833333	2,333333	2,250000	2,166667	1,916667	1,750000	2,083333	2,750000
7	1,916667	2,333333	2,250000	2,416667	2,916667	3,333333	2,333333	2,666667	2,666667	2,250000
8	2,333333	2,666667	2,200000	2,066667	3,266667	2,933333	2,800000	2,533333	3,000000	2,400000

	11 TOFCIN	12 GOVLDR	13 GOVRGL	14 RATSTR	15 DEDHDS	16 MYRSRT	17 SRPLDR	18 LABORR	19 LOCUBE	20 RIVLRY
1	2,172414	3,206897	2,793103	1,724138	1,931034	2,689655	2,379310	2,827586	2,172414	2,344828
2	1,909091	3,045455	2,590909	1,727273	1,772727	2,636364	2,409091	2,136364	2,863636	2,272727
3	2,111111	3,111111	2,277778	1,722222	1,944444	3,000000	2,444444	1,722222	2,333333	2,222222
4	2,388889	2,777778	2,611111	1,888889	1,777778	2,500000	2,444444	2,000000	2,555556	2,333333
5	2,095238	2,619048	2,428571	2,000000	1,904762	3,047619	2,333333	1,523810	2,095238	2,190476
6	2,750000	2,833333	2,500000	2,000000	1,416667	3,000000	2,583333	1,750000	2,500000	2,333333
7	2,333333	3,500000	2,833333	2,083333	2,500000	3,333333	2,750000	2,250000	2,250000	2,333333
8	2,133333	3,400000	2,466667	1,938333	2,066667	2,066667	2,333333	1,733333	2,200000	2,466667

1 = Large durable goods manufacturer
2 = Small durable goods manufacturer
3 = Large nondurable goods manufacturer
4 = Small nondurable goods manufacturer
5 = Large retailer
6 = Small retailer
7 = Large forwarder
8 = Small forwarder

Table 44. Multivariate and univariate tests of Hypothesis 2-B

GROUP EFFECT

F-RATIO FOR MULTIVARIATE TEST OF EQUALITY OF MEAN VECTORS= 1.1949

D.F.= 60 AND 358.8489 P LESS THAN 0.1667

	VARIABLE	BETWEEN MEAN SQ	UNIVARIATE F	P LESS THAN	STEP DOWN F	P LESS THAN
1	NONSTD	0.2931	0.2350	0.8719	0.2350	0.8719
2	INVSMT	2.1783	1.6698	0.1764	1.6293	0.1855
3	BENFTS	1.2637	1.1860	0.3175	1.4833	0.2219
4	RESPBT	0.6196	0.4254	0.7352	0.4677	0.7053
5	BRIDGE	2.2838	1.4124	0.2418	2.3193	0.0783
6	IMOWNR	3.1196	2.0259	0.1131	2.5557	0.0580
7	INTRCG	3.1540	2.4528	0.0660	1.5232	0.2115
8	SHORTS	1.7731	1.2264	0.3026	0.5879	0.6240
9	HOLDUP	1.9446	1.2740	0.2858	0.7220	0.5406
10	TOFCAL	0.2095	0.1745	0.9136	0.2913	0.8316
11	TOFCIN	0.5685	0.4747	0.7005	0.9999	0.3953
12	GOVLDR	3.0341	1.7440	0.1609	1.3501	0.2612
13	GOVRGL	0.6816	0.4566	0.7131	0.5419	0.6545
14	RATSTR	0.7347	0.6929	0.5579	1.3361	0.2657
15	DEDHDS	1.5304	1.6824	0.1736	2.7535	0.0454
16	MTRSPT	1.1058	1.0089	0.3909	2.1899	0.0950
17	SHPLDR	0.0963	0.0891	0.9660	0.0979	0.9611
18	LABORR	0.9770	0.7341	0.5334	1.7286	0.1647
19	LOCUBE	0.6137	0.5740	0.6331	0.3531	0.7870
20	RIVLRY	0.1476	0.1248	0.9453	0.7769	0.5091

DEGREES OF FREEDOM FOR HYPOTHESIS= 3

DEGREES OF FREEDOM FOR ERROR= 139

Table 45. Multivariate and univariate tests of Hypothesis 3-B

SIZE EFFECT

F-RATIO FOR MULTIVARIATE TEST OF EQUALITY OF MEAN VECTORS= 1.7094

D.F.= 20 AND 120.0000 P LESS THAN 0.0407

	VARIABLE	BETWEEN MEAN SQ	UNIVARIATE F	P LESS THAN	STEP DOWN F	P LESS THAN
1	NONSTD	1.2237	0.9813	0.3236	0.9813	0.3236
2	INVSMT	0.6121	0.4692	0.4945	0.2617	0.6541
3	BENFTS	0.3872	0.3634	0.5477	0.0662	0.7974
4	RESPBT	2.5953	1.7816	0.1842	3.0315	0.0840
5	BRIDGG	2.4394	1.5087	0.2215	2.6435	0.1064
6	IMOWNR	0.1048	0.0681	0.7946	0.5281	0.4687
7	INTRCG	0.8802	0.6845	0.4095	0.8382	0.3616
8	SHORTS	2.0486	1.4169	0.2360	0.8060	0.3710
9	HOLDUP	2.6531	1.7381	0.1896	0.1885	0.6650
10	TOFCAL	2.4041	2.0024	0.1593	3.2462	0.0740
11	TOFCIN	0.2304	0.1924	0.6617	0.1090	0.7418
12	GOVLDR	0.4580	0.2633	0.6088	0.4898	0.4853
13	GOVRGL	0.0570	0.0382	0.8455	0.0166	0.8978
14	RATSTR	0.0081	0.0077	0.9304	0.1211	0.7285
15	DEDHDS	2.8465	3.1292	0.0791	4.8327	0.0298
16	MTRSPT	5.4532	4.9753	0.0274	2.6697	0.1049
17	SHPLDR	0.0069	0.0064	0.9366	0.1191	0.7307
18	LABORR	0.6026	0.4527	0.5022	1.0607	0.3051
19	LOCUBE	5.0173	4.6921	0.0321	7.7974	0.0061
20	RIVLRY	0.1206	0.1020	0.7500	2.5218	0.1150

DEGREES OF FREEDOM FOR HYPOTHESIS= 1
DEGREES OF FREEDOM FOR ERROR= 139

Table 46. Mean values used to test Hypothesis 4-A,B

FINN*S MULTIVARIANCE ANALYSIS PROGRAM • EDUCATION COLLEGE CONTAINERIZATION QUESTIONNAIRE • ANALYSIS OF 4 GROUPS

PAGE 4

CELL MEANS --- ROWS ARE CELLS COLUMNS ARE VARIABLES

	1 NONSTD	2 INVSMT	3 BENFTS	4 RESPBT	5 BRIDGE	6 IMOWNR	7 INTRCG	8 SRORTS	9 HOLDUP	10 TOFCAL
1	1,985507	2,333333	2,623188	2,347826	3,217391	2,492754	2,014493	2,333333	2,492754	2,376812
2	2,076923	2,653846	2,923077	2,692308	2.846154	2,384615	1,923077	1,884615	2,192308	2,115385
3	2,000000	2,040000	2,040000	2,240000	3,040000	2,600000	1,960000	2,120000	2,240000	2,160000
4	2,148148	2,518519	2,222222	2,222222	3,111111	3,111111	2,592593	2,592593	2,851852	2,333333

	11 TOFCIN	12 GOVLDR	13 GOVRGL	14 RATSTR	15 DEDHDS	16 MTRSPT	17 SHPLDR	18 LABORR	19 LOCUBE	20 RIVLRY
1	2,202899	3,115942	2,623188	1.840580	1.869565	2,768116	2,463768	2,000000	2,434783	2,304348
2	2,230769	2,846154	2,576923	1.807692	1.730769	2,884615	2,500000	1,653846	2,307692	2,192308
3	2,120000	2,640000	2,360000	1,800000	1,800000	2,760000	2,200000	1,560000	2,400000	2,320000
4	2,222222	3,444444	2,629630	2,000000	2.259259	2,629630	2,518519	1,962963	2,222222	2,407407

1 = Shipper 3 = Shipper and consignee

2 = Consignee 4 = Forwarder

Table 47. Multivariate and univariate tests of Hypothesis 4-B

GROUP EFFECT

F-RATIO FOR MULTIVARIATE TEST OF EQUALITY OF MEAN VECTORS= 1.0133

D.F.= 60 AND 370.7827 P LESS THAN 0.4546

	VARIABLE	BETWEEN MEAN SQ	UNIVARIATE F	P LESS THAN	STEP DOWN F	P LESS THAN
1	NONSTD	0.1970	0.1563	0.9256	0.1563	0.9256
2	INVSMT	1.8344	1.4185	0.2399	1.3472	0.2616
3	BENFTS	4.3575	4.4612	0.0050	4.1117	0.0079
4	RESPBT	1.2487	0.8650	0.4609	0.5263	0.6650
5	BRIDGE	0.9063	0.5474	0.6507	1.0299	0.3815
6	IMOWNR	3.0163	1.9600	0.1227	2.4944	0.0626
7	INTRCG	2.7855	2.1612	0.0953	1.2811	0.2835
8	SHORTS	2.5025	1.7791	0.1539	0.9951	0.3973
9	HOLDUP	2.4307	1.5999	0.1921	0.6888	0.5604
10	TOFCAL	0.5944	0.4936	0.6874	0.7202	0.5416
11	TOFCIN	0.0658	0.0544	0.9833	0.3833	0.7653
12	GOVLDR	3.2610	1.9199	0.1291	1.2603	0.2908
13	GOVRGL	0.4649	0.3157	0.8141	0.3871	0.7626
14	RATSTR	0.2384	0.2284	0.8766	0.2283	0.8766
15	DEDHDS	1.5133	1.6631	0.1777	1.8836	0.1356
16	MTRSPT	0.2889	0.2462	0.8640	1.1229	0.3424
17	SHPLDR	0.5786	0.5502	0.6489	0.1407	0.9355
18	LABORR	1.6641	1.2725	0.2862	1.4811	0.2229
19	LOCURE	0.3339	0.3038	0.8227	0.0525	0.9841
20	RIVLRY	0.2063	0.1792	0.9104	0.5070	0.6782

DEGREES OF FREEDOM FOR HYPOTHESIS= 3

DEGREES OF FREEDOM FOR ERROR= 143

Table 48. Mean values used to test Hypothesis 5-A,B

FINN'S MULTIVARIANCE ANALYSIS PROGRAM • EDUCATION COLLEGE CONTAINERIZATION QUESTIONNAIRE • ANALYSIS OF 5 GROUPS

PAGE 4

CELL MEANS --- ROWS ARE CELLS COLUMNS ARE VARIABLES

	1 NONSTD	2 INVSMT	3 BENFTS	4 RESPBT	5 BRIDGE	6 IMOWNR	7 INTRCG	8 SHORTS	9 HOLDUP	10 TOFCAL
1	1,515152	2,121212	2,060606	2,303030	3,363636	2,939394	2,121212	2,272727	2,757576	2,818182
2	2,095238	1,904762	2,523810	2,285714	3,666667	2,523810	2,190476	2,809524	2,714286	1,761905
3	2,866667	2,000000	2,400000	2,200000	3,400000	2,933333	3,266667	2,466667	2,733333	3,333333
4	2,000000	2,428571	2,857143	2,500000	3,928571	3,214286	2,071429	3,071429	3,214286	3,071429
5	3,153846	2,230769	2,692308	1,692308	3,615385	2,230769	1,538462	2,923077	2,538462	3,230769

	11 TOFCIN	12 GOVLDR	13 GOVRGL	14 RATSTR	15 DEDHDS	16 MTRSPT	17 SHPLDR	18 LABORR	19 LOCUBE	20 RIVLRY
1	2,303030	3,030303	2,939394	2,121212	1,484848	2,666667	1,666667	1,969697	1,696970	2,272727
2	2,238095	3,476190	2,714286	2,000000	1,666667	2,666667	2,476190	1,952381	2,285714	2,761905
3	3,066667	2,666667	1,866667	1,133333	2,133333	2,600000	3,000000	2,266667	3,133333	2,866667
4	2,285714	2,857143	2,928571	1,714286	1,571429	3,214286	2,714286	2,714286	3,071429	2,500000
5	3,307692	2,846154	2,461538	1,461538	1,769231	2,923077	2,153846	1,769231	2,692308	2,000000

1 = Motor carrier
2 = Rail carrier
3 = Marine carrier
4 = Air carrier
5 = Port authority

Table 49. Multivariate and univariate tests of Hypothesis 5-B

F-RATIO FOR MULTIVARIATE TEST OF EQUALITY OF MEAN VECTORS= 2.0707

D.F.= 80 AND 288.4522 P LESS THAN 0.0001

	VARIABLE	BETWEEN MEAN SQ	UNIVARIATE F	P LESS THAN	STEP DOWN F	P LESS THAN
1	NONSTD	8.6202	7.1653	0.0001	7.1653	0.0001
2	INVSMT	0.6697	0.4650	0.7613	1.0908	0.3660
3	BENFTS	2.0332	1.5787	0.1867	1.1088	0.3575
4	RESPBT	1.2584	0.9241	0.4536	1.2523	0.2950
5	BRIDGE	0.9578	0.6922	0.5993	1.0376	0.3926
6	IMOWNR	2.2796	1.2594	0.2918	0.9426	0.4434
7	INTRCG	5.7781	4.5389	0.0022	4.5533	0.0023
8	SHORTS	2.2829	1.5123	0.2052	1.4335	0.2301
9	HOLDUP	0.8847	0.6346	0.6392	1.2337	0.3030
10	TOFCAL	7.5503	5.5730	0.0005	4.4152	0.0028
11	TOFCIN	4.1236	3.3108	0.0141	1.4878	0.2136
12	GOVLDR	1.7527	1.0854	0.3686	1.2371	0.3019
13	GOVRGL	3.3998	2.6206	0.0400	1.9334	0.1131
14	RATSTR	3.1242	3.4954	0.0106	2.3928	0.0577
15	DEDHDS	1.1527	1.7373	0.1486	0.5981	0.6651
16	MTRSPT	1.0195	0.8076	0.5235	0.3550	0.8398
17	SHPLDR	5.9594	5.4711	0.0006	2.3925	0.0581
18	LABORR	2.0340	1.7794	0.1398	1.1759	0.3285
19	LOCURE	8.0133	4.8392	0.0014	1.4171	0.2369
20	RIVLRY	2.0795	1.8268	0.1305	2.4365	0.0549

DEGREES OF FREEDOM FOR HYPOTHESIS= 4

DEGREES OF FREEDOM FOR ERROR= 91

Table 50. Contingency table for testing Hypothesis 6

NUCROS 2.01 09/04/70

TABLE NO. 4 VARIABLE NO. 3 FORN CONTR
VRS. VARIABLE NO. 2 DOMES COFC

	TOT	0	1	2
0	0	0	0	0
1	96	0	37	59
2	67	0	15	52
TOTAL	163	0	52	111

CHI SQUARE = 4.740 C = .168 TAU-B = .171 GAMMA = .370 DXY = .162 DYX = .180

PERCENTS BY COLUMN FROM THE ABOVE MATRIX

1	58.9		71.2	53.2
2	41.1		28.8	46.8
TOTAL	163		52	111

1 = No

2 = Yes

PERCENTS BY ROW FROM THE ABOVE MATRIX

1	96		38.5	61.5
2	67		22.4	77.6
TOTAL	163		31.9	68.1

Rows = Domestic containerization

Columns = Foreign containerization

Table 51. Contingency table for testing Hypothesis 7

NUCROS 2.01 09/04/70

TABLE NO. 3 VARIABLE NO. 1 DOMES TOFC
VRS. VARIABLE NO. 2 DOMES COFC

	TOT	0	1	2
0	0	0	0	0
1	95	0	21	74
2	67	0	11	56
TOTAL	162	0	32	130

CHI SQUARE = .802 C = .070 TAU-B = .070 GAMMA = .182 DXY = .057 DYX = .087

PERCENTS BY COLUMN FROM THE ABOVE MATRIX

1	58.6	65.6	56.9
2	41.4	34.4	43.1
TOTAL	162	32	130

1 = No
2 = Yes

PERCENTS BY ROW FROM THE ABOVE MATRIX

1	95	22.1	77.9
2	67	16.4	83.6
TOTAL	162	19.8	80.2

Rows = Containerized freight
Columns = TOFC piggyback

Table 52. Contingency table for testing Hypothesis 8

NUCROS 2.01 09/04/70

TABLE NO. 9 VARIABLE NO. 4 OWN CONTR
VRS. VARIABLE NO. 8 FRT ACTVTY

	TOT	0	1	2
0	0	0	0	0
1	56	0	53	3
2	21	0	21	0
3	22	0	22	0
4	21	0	17	4
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
9	16	0	15	1
TOTAL	136	0	128	8

CHI SQUARE = 9.294

PERCENTS BY COLUMN FROM THE ABOVE MATRIX

	TOT	0	1	2
1	41.2		41.4	37.5
2	15.4		16.4	0.0
3	16.2		17.2	0.0
4	15.4		13.3	50.0
5	0.0		0.0	0.0
6	0.0		0.0	0.0
7	0.0		0.0	0.0
8	0.0		0.0	0.0
9	11.8		11.7	12.5
TOTAL	136		128	8

Column 1 = No
Column 2 = Yes
Row 1 = Shipper
Row 2 = Consignee
Row 3 = Shipper and consignee
Row 4 = Freight forwarder
Row 9 = Equipment Supplier as Freight User

PERCENTS BY ROW FROM THE ABOVE MATRIX

	TOT	0	1	2
1	56		94.6	5.4
2	21		100.0	0.0
3	22		100.0	0.0
4	21		81.0	19.0
5	0		0.0	0.0
6	0		0.0	0.0
7	0		0.0	0.0
8	0		0.0	0.0
9	16		93.8	6.3
TOTAL	136		94.1	5.9

Table 53. Contingency table for testing Hypotheses 9 and 10--domestic shipments (four third-dimension tables in the set)

NUCROS 2.01 09/04/70

TABLE NO. 2 VARIABLE NO. 2 DOMES COFC
VRS. VARIABLE NO. 6 BLS SIZE
VRS. VARIABLE NO. 7 BLS TYPE

3RD DIMENSION = 1
CHI SQUARE = .973

	TOT	0	1	2
0	0	0	0	0
1	32	0	21	11
2	38	0	29	9
TOTAL	70	0	50	20

Column 1 = No use of domestic containerization
Column 2 = Yes, use of domestic containerization
Row 1 = Larger firm
Row 2 = Smaller firm

PERCENTS BY COLUMN FROM THE ABOVE MATRIX

1	45.7	42.0	55.0
2	54.3	58.0	45.0
TOTAL	70	50	20

3rd Dimension 1 = Durable goods manufacturer
3rd Dimension 2 = Nondurable goods manufacturer
3rd Dimension 3 = Retailer
3rd Dimension 4 = Freight forwarder

PERCENTS BY ROW FROM THE ABOVE MATRIX

1	32	65.6	34.4
2	38	76.3	23.7
TOTAL	70	71.4	28.6

Table 54. Contingency table for testing Hypotheses 9 and 10--foreign shipments (four third-dimension tables in the set)

NUCROS 2.01 09/04/70

TABLE NO. 3 VARIABLE NO. 3 FORN CONTR
VRS, VARIABLE NO. 6 BUS SIZE
VRS, VARIABLE NO. 7 BUS TYPE

3RD DIMENSION = 1 CHI SQUARE = 12.244

	TOT	0	1	2
0	0	0	0	0
1	33	0	5	28
2	38	0	21	17
TOTAL	71	0	26	45

PERCENTS BY COLUMN FROM THE ABOVE MATRIX

1	46.5	19.2	62.2
2	53.5	80.8	37.8
TOTAL	71	26	45

PERCENTS BY ROW FROM THE ABOVE MATRIX

1	33	15.2	84.8
2	38	55.3	44.7
TOTAL	71	36.6	63.4

Column 1 = No use of foreign containerization
Column 2 = Yes, use of foreign containerization
Row 1 = Larger firm
Row 2 = Smaller firm

3rd Dimension 1 = Durable goods manufacturer
3rd Dimension 2 = Nondurable goods manufacturer
3rd Dimension 3 = Retailer
3rd Dimension 4 = Freight forwarder

Table 55. Contingency table for testing Hypothesis 11--domestic shipments

NUCROS 2.01 09/04/70

TABLE NO. 7 VARIABLE NO. 2 DOMES COFC
VRS. VARIABLE NO. 8 FRT ACTVTY

CHI SQUARE = 3.164

	TOT	0	1	2
0	0	0	0	0
1	65	0	39	26
2	26	0	16	10
3	25	0	15	10
4	23	0	10	13
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
9	22	0	15	7
TOTAL	161	0	95	66

Column 1 = No
Column 2 = Yes
Row 1 = Shipper
Row 2 = Consignee
Row 3 = Shipper and consignee
Row 4 = Freight forwarder
Row 9 = Equipment Supplier as Freight User

PERCENTS BY COLUMN FROM THE ABOVE MATRIX

1	40.4	41.1	39.4
2	16.1	16.8	15.2
3	15.5	15.8	15.2
4	14.3	10.5	19.7
5	0.0	0.0	0.0
6	0.0	0.0	0.0
7	0.0	0.0	0.0
8	0.0	0.0	0.0
9	13.7	15.8	10.6
TOTAL	161	95	66

PERCENTS BY ROW FROM THE ABOVE MATRIX

1	65	60.0	40.0
2	26	61.5	38.5
3	25	60.0	40.0
4	23	43.5	56.5
5	0	0.0	0.0
6	0	0.0	0.0
7	0	0.0	0.0
8	0	0.0	0.0
9	22	68.2	31.8
TOTAL	161	59.0	41.0

Table 56. Contingency table for testing Hypothesis 11--foreign shipments

NUCROS 2.01 09/04/70

TABLE NO. 8 VARIABLE NO. 3 FORN CONTR
VRS. VARIABLE NO. 8 FRT ACTVTY

CHI SQUARE = 5.262

	TOT	0	1	2
0	0	0	0	0
1	67	0	20	47
2	26	0	9	17
3	25	0	5	20
4	24	0	7	17
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
9	22	0	11	11
TOTAL	164	0	52	112

Column 1 = No

Column 2 = Yes

Row 1 = Shipper

Row 2 = Consignee

Row 3 = Shipper and consignee

Row 4 = Freight forwarder

Row 9 = Equipment Supplier as Freight User

PERCENTS BY COLUMN FROM THE ABOVE MATRIX

1	40.9	38.5	42.0
2	15.9	17.3	15.2
3	15.2	9.6	17.9
4	14.6	13.5	15.2
5	0.0	0.0	0.0
6	0.0	0.0	0.0
7	0.0	0.0	0.0
8	0.0	0.0	0.0
9	13.4	21.2	9.8
TOTAL	164	52	112

PERCENTS BY ROW FROM THE ABOVE MATRIX

1	67	29.9	70.1
2	26	34.6	65.4
3	25	20.0	80.0
4	24	29.2	70.8
5	0	0.0	0.0
6	0	0.0	0.0
7	0	0.0	0.0
8	0	0.0	0.0
9	22	50.0	50.0
TOTAL	164	31.7	68.3

Table 57. Relationship between containerizability of goods and freight activity

NUCROS 2.01 09/04/70

TABLE NO. 10 VARIABLE NO. 5 CONTRIZABL
VRS. VARIABLE NO. 8 FRT ACTVTY

CHI SQUARE = 2.859

Column 1 = No
Column 2 = Yes
Row 1 = Shipper
Row 2 = Consignee
Row 3 = Shipper and consignee
Row 4 = Freight forwarder
Row 9 = Equipment Supplier as Freight User

	TOT	0	1	2
0	0	0	0	0
1	67	0	0	67
2	26	0	1	25
3	25	0	1	24
4	24	0	1	23
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
9	22	0	1	21
TOTAL	164	0	4	160

PERCENTS BY COLUMN FROM THE ABOVE MATRIX

1	40.9	0.0	41.9
2	15.9	25.0	15.6
3	15.2	25.0	15.0
4	14.6	25.0	14.4
5	0.0	0.0	0.0
6	0.0	0.0	0.0
7	0.0	0.0	0.0
8	0.0	0.0	0.0
9	13.4	25.0	13.1
TOTAL	164	4	160

PERCENTS BY ROW FROM THE ABOVE MATRIX

1	67	0.0	100.0
2	26	3.8	96.2
3	25	4.0	96.0
4	24	4.2	95.8
5	0	0.0	0.0
6	0	0.0	0.0
7	0	0.0	0.0
8	0	0.0	0.0
9	22	4.5	95.5
TOTAL	164	2.4	97.6

Table 58. Mean values used to evaluate bias from Form I and Form II Questionnaire

FINN'S MULTIVARIANCE ANALYSIS PROGRAM - EDUCATION COLLEGE CONTAINERIZATION QUESTIONNAIRE - TWO FORMS

PAGE 4

CELL MEANS --- ROWS ARE CELLS COLUMNS ARE VARIABLES

	1 VONSTD	2 INVSHT	3 BENFTS	4 RESPBT	5 BRIDGE	6 IMOWNR	7 INTRCG	8 SHORTS	9 HOLDUP	10 TOFCAL
1	2,136364	1,931818	2,295455	2,340909	3,250000	2,454545	2,113636	2,522727	2,750000	2,863636
2	1,954545	2,295455	2,704545	2,386364	3,068182	2,522727	2,227273	2,363636	2,386364	2,386364

	11 TOFCIN	12 GOVLDR	13 GOVRGL	14 RATSTR	15 DEDHDS	16 MTRSPT	17 SHPLDR	18 LABORR	19 LOCUBE	20 RIVLRY
1	2,636364	2,840909	2,659091	1,772727	1,840909	2,886364	2,318182	2,272727	2,340909	2,613636
2	2,113636	3,204545	2,545455	1,704545	1,704545	2,613636	2,500000	1,772727	2,522727	2,363636

Row 1 = Form I

Row 2 = Form II

Table 59. Mean values used to test for bias from first and follow-up mailings

FINN'S MULTIVARIANCE ANALYSIS PROGRAM - EDUCATION COLLEGE CONTAINER QUESTIONNAIRE-ANALYSIS OF FOLLOW-UP GROUP

PAGE 4

CELL MEANS --- ROWS ARE CELLS COLUMNS ARE VARIABLES

	1 VONSTD	2 INVSMT	3 BENFTS	4 RESPBT	5 BRIDGE	6 IMOWNR	7 INTRCG	8 SHORTS	9 HOLDUP	10 TOFCAL
1	2.112150	2.373832	2.448598	2.336449	3.168224	2.700935	2.149533	2.280374	2.420561	2.158879
2	1.888889	2.518519	2.888889	2.444444	3.000000	2.370370	1.962963	2.296296	2.555556	2.518519

	11 TOFCTN	12 GOVLDR	13 GOVRGL	14 RATSTR	15 DEDHDS	16 MTRSPT	17 SHPLDR	18 LABORR	19 LOCUBE	20 RIVLRY
1	2.121495	3.037383	2.579439	1.897196	1.943925	2.757009	2.429907	1.906542	2.364486	2.233645
2	2.185185	3.444444	2.518519	1.888889	1.851852	2.592593	2.518519	1.740741	2.296296	2.481481

Row 1 = Initial mailing

Row 2 = Follow-up mailing

GLOSSARY OF COMPUTER PROGRAM LABELS

Questionnaire Factor or Variable	Label
1. NONSTANDARD CONTAINERS	NONSTD
2. INVESTMENT REQUIREMENTS	INVSMT
3. DISTRIBUTION OF BENEFITS	BENFTS
4. DIVIDED CARRIER RESPONSIBILITY	RESPBT
5. LACK OF LAND BRIDGE	BRIDGE
6. INTERMODAL OWNERSHIP FORBIDDEN	IMOWNR
7. INADEQUATE CONTAINER INTERCHANGE	INTRCG
8. CONTAINER AND CHASSIS SHORTAGES	SHORTS
9. TERMINAL HOLDUPS	HOLDUP
10. TOFC ALTERNATIVE	TOFCAL
11. EXISTING TOFC INVESTMENTS	TOFCIN
12. LACK OF GOVERNMENT LEADERSHIP	GOVLDR
13. GOVERNMENTAL REGULATION	GOVRGL
14. INADEQUATE RATE STRUCTURES	RATSTR
15. EMPTY CONTAINER TRAFFIC AND TARIFFS	DEDHDS
16. LACK OF MOTOR CARRIER SUPPORT	MTRSPT
17. SHIPLINE LEADERSHIP	SHPLDR
18. LABOR RESISTANCE	LABORR
19. INEFFICIENT CONTAINER CUBE vs VANS	LOCUBE
20. INTERMODAL RIVALRY	RIVLRY
Use of containerization in domestic trade	DOMES COFC
Use of TOFC piggyback in domestic trade	DOMES TOFC
Use of containerization in foreign trade	FORN CONTR
Ownership of containers	OWN CONTR
Goods are deemed containerizable	CONTRIZABL
Business size category (larger or smaller)	BUS SIZE
Durable, nondurable, retailer, other type	BUS TYPE
Freight activity (User, Carrier, Equipment Supplier and respective subgroups)	FRT ACTVTY

APPENDIX C

FOLLOW-UP INTERVIEW COMMENTS

COMMENTS FROM THE FOLLOW-UP INTERVIEWS

The interview questions were developed from preliminary analysis of the original questionnaire replies. Most of the interviewees were contacted while the writer was attending a container trade show. Before being asked to answer specific questions subjects were first shown a copy of the questionnaire and were familiarized with generalities of the research program. The interview questions are listed below along with a condensation of replies.

Question 1: About 98 percent of the freight users claimed that some or all of their goods was containerizable, but only about 40 percent stated they shipped or received containerized freight in domestic shipments. All respondent sectors listed the lack of adequate shipment rate structures among the top factors limiting development of domestic surface containerization. Would you comment on the limitations of present rate structures and do you have any suggestions as to how they might be adjusted to promote containerization?

Comments:

> There is no rate incentive on the part of shippers to go to containers. There doesn't appear to be sufficient economic advantage to cover investment in new methods and to allow rate reductions at the same time.
>
> Going to containers increases operating costs. The number of bogey/chassis required increases as points of service increase. Terminal handling devices are required.

Motor carriers don't feel pressure from shippers to move containers. Twenty foot containers present a problem to truckers and they haven't noted economies which offer reasons to reduce rates.

The thrust of through rate structures is mainly directed to overseas traffic. Domestic rate scales are built around the 40 foot trailer. Some of the Eastern railroads are restricting COFC [Container on Flatcar] movements.

We [a rail carrier] have found no limitations as a result of existing rate structures. You can load as much freight in a 40 foot container as you can in a 40 foot trailer and the same rates apply to either.

Through rate bureaus are needed to determine what the fair rates should be. A shipper should be able to call any truck line and obtain a standardized rate.

Question 2: Cost of "dead head" movements and non-standard empty container rates are also at the top of the list as problems in the development of domestic containerization. Are you aware of any actions being taken and do you have any suggestions to relieve this problem?

Comments:

You have no more problem with dead heading containers than you have with dead heading trailers. You are going to be "out-of-balance" in certain cities and it would make no difference if you handled the traffic in a container or in a complete trailer.

Unbalanced loads are a problem in any transportation system. Equipment doesn't change the problem. Balancing loads is a marketing problem. There are plenty of commodities to fill them [on back-hauls] if it is advantageous.

Rates will have to include built-in coverage of the cost of dead head movement. Use of collapsible containers is not an answer.

Container leasors will develop container pools to relieve dead head movement costs. This may reduce the problem by 50 to 60 percent.

<u>Question 3</u>: Is labor resistance to containerization going to be a long-term problem in the domestic freight area? Are there any encouraging developments in this area?

<u>Comments</u>:

There is no particular problem in the trucking industry. More business is welcome to the truckers. Piggyback [TOFC] has not been a problem.

There is no labor problem in the domestic area as compared to the marine area.

In the domestic area, the Teamsters Union would retain the work, whether containers or trailers are used. This eliminates the likelihood of interjuristictional disputes.

<u>Question 4</u>: Nonstandard containers seem to be viewed as a major problem by all but the equipment suppliers. How may this situation be relieved as an impediment to growth of containerization in domestic shipments?

<u>Comments</u>:

By carriers buying equipment that meets standard dimensions as approved by the American National Standards Committee MH-5.

Standards efforts of ANSI and ISO are being pursued. The nonstandard proportion of containers will decline. Lengths of 24 foot, 25 foot, and probably 27 foot containers will be written into the standards and the 10 foot length will be eliminated. There is need to recognize the need for bimodal containers, such as "air/land," for example.

The long-term trend is toward standardization. Heavier demand for 40 foot containers will force nonstandard carriers to change.

The equipment suppliers are trying to make handling and hauling equipment more adaptable. I don't see any movement toward elimination of the existing nonstandard fleet.

Differences in endwall strength, etc., is one area, as compared to another area of standardization in length and size. The fleet has to have some mix to meet shipper needs. Standards on size should have flexibility. Standards on strength, etc., should avoid difficulties in handling.

Standards must be adhered to, otherwise planning for handling equipment is a problem.

Development and use of hi-cube domestic containers measuring 8 foot x 9½ foot high x 40 foot long is needed in order to make containers competitive in low bulk density.

Question 5: Respondents believe that lack of an adequate national container pool is an important limitation to container movements. Do you feel that this problem will be overcome; if so, how will it be accomplished and how long would you expect it to take?

Comments:

A domestic pool is a long way off. We don't have a true national trailer pool. We have extensive interline equipment exchange agreements. We can expect the same type of development for containers.

It will come just as fast as industry can use containers to its economic advantage and just as rapidly as handling equipment becomes available.

There is no advantage to an only domestic pool--you have to include marine carrier needs to be practical.

The lack of a pool is a very serious retarding factor. An equipment interchange agreement would help. Lack of interchange agreements between shiplines needs to be corrected. Economic pressure will force agreement and pools. The Department of Transportation is attempting to work out an agreement.

Do not believe a pool will aid at all for the movement of domestic freight. A container pool would aid in the handling of foreign freight as it would cut down on the dead head miles necessary to secure an empty steamship container now. A pool situation would be created by a trailer/container leasing company becoming so large as to be able to supply the international industry the equipment on a per diem basis such as exists now with Trailer Train, XTRA or REALCO for conventional TOFC moves. This company would supply the equipment to the industry "at large" and then collect per diem from whoever had the equipment on a particular day through regular railroad accounting procedures of voluntary per diem payment.

There is no lack of an adequate national container pool. The leasing companies can easily fill any void.

Question 6: The situation where responsibility for coordination of intermodal movements is divided among the carriers involved is viewed as an important factor, primarily among the carriers. Do you have any suggestions as to how this arrangement might be improved?

Comments:

Shipper associations and freight forwarders might help the problem. A neutral party of any kind to handle intermodal business would help.

There are many legal ramifications to through bills of lading. Marine carriers are protected, while surface carriers are not [from liability claims]. There is a need for legislation to make distribution of damage claims equitable. The ICC and Maritime Commission need to cooperate more closely.

Specialists being assigned by the various modes and liaison developed between the modes will create communication, the lack of which is a problem now.

Question 7: There is some agreement among carriers and equipment suppliers that shipline leadership in developing and promoting containerization has caused some of the problems in domestic containerization. Do you believe there will be a shift in responsibility for development to the domestic carriers; if not, how can this problem be reduced?

Comments:

There are two different standards for foreign and domestic service. Standards will have to be worked out jointly if the traffic is to be handled jointly [intermodally] since each has certain requirements which are necessary for movement via his particular mode. For example: (1) the water and rail carriers need heavier end wall construction [in containers] than do the motor carriers because of rougher rides via these two modes and (2) the water carriers need their containers constructed of particular metals which will not deteriorate while around salt air or water. These requirements are not needed by rail or motor.

The railroads will have to be the leader.

Shiplines are going to have to share some of the savings with surface carriers. Domestic carriers want a bigger voice in establishment of standards in fabrication and marking.

The trend is toward increased use of 40 foot containers; the 20 foot container developed as the result of marine leadership.

Practically every container will be built for intermodal operations. Longevity of equipment may help to offset the cost for marine containers. Increased domestic movement will cause increased participation by domestic carriers in leadership activities. Shippers will force cooperation.

Question 8: For the most part, governmental regulation and the lack of government leadership in developing domestic containerization are not considered serious factors. Is there likely to be any change in the role of government in this area of freight activity? What might governmental agencies do to help in development of domestic containerization?

Comments:

A "hands-off" attitude by governmental agencies would be helpful. However, more active interest in standardization groups would be helpful.

Increased effort at coordination of the individual modes is needed.

The military has been making attempts at standardization. The Department of Transportation is taking an active part in container standardization. The Department of Agriculture, Labor Department, and others are active participants in container standards work.

I see no way the government could aid domestically. This is strictly an economic situation which will have to be decided upon by a particular carrier.

The governmental agencies are not sincerely interested in developing containerization. They will have to be pushed into it slowly, by all carriers.

Question 9: After looking over the factors included in the questionnaire, do you have any additional suggestions on changes which might be made to aid in development of domestic containerization? Are there any additional factors which have not been discussed which are important to the problem?

Comments:

The key [at smaller freight centers] is the handling equipment. Unless a piece of equipment can be made available to compete with a piggyback ramp, you might as well forget about domestic containerization. The only piece of equipment presently capable of handling any containers at an inland point is the Steadman Side Loader. Both Canadian railroads use this for their domestic as well as intermodal shipments.

The basic reasons for containerizing domestic freight are listed below and result in handling traffic more economically than if handled in a conventional trailer. (a) Less capital investment to begin with. You buy fewer wheels than for trailers since you do not need wheels while the container is aboard a rail car. (b) Lower center of gravity for the rail move results in (1) less lading damage as a result of an easier ride and (2) less wind resistance enabling the locomotive to pull more. (c) Lower height of container loaded on car allows moves not possible for trailers because of clearance restrictions, i.e., low tunnels or bridges.

Lack of overall interest on the part of shippers. The National Industrial Traffic League has been very negative toward containers. Underutilization of equipment is a problem; lack of coordination is a problem, especially with rail cars.

The amount of freight in import/export tonnage is relatively small compared to domestic freight tonnage. A large proportion of container freight originates close to the ports. The international and domestic container systems need to be integrated.

The main problem is going to be the training of people--exposure of the art to the business community--solving the problem of availability of handling equipment.