PHYSICAL DISTRIBUTION PATTERNS IN THE METALS SERVICE CENTER INDUSTRY

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THESIS

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ABSTRACT

PHYSICAL DISTRIBUTION PATTERNS IN THE
METALS SERVICE CENTER INDUSTRY

By

Peter Michael Lynagh

The subject matter of this research is physical distribution patterns as they exist in the Metals Service Center industry. The specific purposes of this research were to: (1) compare the existing physical distribution patterns with a maximum performance model (2) determine if size will affect the relationship of a Metals Service Center to the maximum performance model (3) determine if profit will affect the relationship of a Center to the maximum performance model (4) compare differences of opinion regarding customer service among those holding different jobs within the Center.

The first phase of the research was to develop a maximum performance model of physical distribution patterns for this industry. This model describes, verbally, the system that should be in operation in this industry. This model contains thirty-seven of the most important physical distribution factors. The system was broken down into three sub-classifications -- order processing which

contained ten factors, warehousehandling which contained ten factors, and transportation which had seventeen factors.

A measurement system was developed based on a four point scale. When a sample Center was completely congruent with the model on a factor, three points were awarded. Zero points were scored on a factor when the sample Center was the antithesis of the model.

The second phase of the research was to select a sample of Centers, study their physical distribution patterns and then compare these patterns with the model. Twenty-four Service Centers comprised the sample. These twenty-four were selected to give the study variety in terms of the type of product sold and size of Center. In addition, some Centers were independent while others were part of a chain. These Centers were located in seven geographic regions covering most of the United States. Personal interviews which lasted about eight hours were conducted at each Center.

The final phase of the research evaluated differences of opinion regarding customer service among those holding different jobs within the Center. If the Center is to be a cohesive unit and work as a system, then incumbents in various assignments should share similar attitudes toward customer service. The job classifications were inside sales, outside sales, warehouse manager and company executive. Each respondent within the job classifications

at the twenty-four sample Centers was given a questionnaire. This questionnaire contained ten questions relating to service.

Based on the research results, Metals Service Centers are presently performing the physical distribution functions below the levels suggested in the maximum performance model. This is true for the entire physical distribution system and for each of the sub-classifications -- order processing, warehouse handling and transportation.

The research showed that no significant difference exists between Metals Service Center of various size and the maximum performance model. This was true for the entire system and for each of the sub-classifications.

The research findings also showed that no difference exists between Metal Service Centers of various profit classifications and the model. This was true for the complete physical distribution operation and for each of the sub-classifications.

The research results showed that no significant difference of opinion exists regarding customer service among those holding different jobs within the Metals Service Center.

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By

Peter Michael Lynagh

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CHAPTER I

INTRODUCTION

Importance of Research

Metal Service Centers serve as the distribution arm of the metals industry. Centers[1] are set up to service buyers who do not have the volume to purchase from the mill. Centers purchase from the mill in carload or truckload quantities. Metals are received at the Center, placed in storage racks, selected, in some cases pre-production processed, then less-than-carload or less-than-truckload shipments are sent to the final customer. Centers are classified under S. I. C. 5091 as "Ferrous Metals Service Centers and Non-Ferrous Metals Service Centers".

At one time, Centers were almost exclusively in the business of performing wholesale function. Large quantities of metal would be purchased from the mill; smaller quantitities would then be sold to customers generated by the Center. Today pre-production processing is a vital

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[1]Throughout this thesis Metal Service Centers will be referred to as Centers.

and important part of the activity of the modern Service Center. Seventy-five per cent of all orders shipped by the Centers are processed in some manner.[1]

Metals Service Centers handle a variety of products. Steel, aluminum, brass, bronze and copper are the primary metals carried. Centers also carry plastics and composites, as well as metals coated with various other materials such as vinyl. Steel is the major product moving through Centers. In 1968, Centers handled 16.1 million tons of domestic steel products. These represented 17.5 per cent of the total tons shipped by the domestic mills.

There are over 400 firms which belong to the Steel Service Center Institute, a trade association representing firms in the steel industry; and, these 400 operate 900 Centers across the country.[2] Traditionally, many of these Centers are small family-run businesses. In addition, there are other Centers which do not belong to the SSCI. SSCI members do in excess of 80 per cent of the business shipped.[3]

Physical distribution is a major competitive factor in the Metals Service Center industry. The product is

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[1]Robert G. Welch, President of the Steel Service Center Institute, in a letter to this writer, dated April 23, 1970.

[2]Steel Service Center Institute, 1969-1970 Roster of Members (Cleveland, Ohio: Steel Service Center Institute, 1969), p. 4.

[3]Robert G. Welch, op. cit.

homogeneous and the general level of prices is approximately the same between Centers in the same area. Location does not provide a competitive edge as major population centers have many competing Centers. In New York City, there are 70 Centers which belong to the Steel Service Center Institute.[1] Promotion is important, especially inside and outside selling, but often promotion is centered around the Center's physical distribution capability.

The focal point of competitive action becomes the activities which must be undertaken in order to affect delivery of the product to the customer at the desired time. In this industry, first day delivery is expected on non-processed order. Delivery requirements for processed orders are set by demand conditions in an area for a particular type of processing. If a firm is to be an effective competitor, it must be able to quote competitive delivery dates and have the physical distribution system to back up these commitments.

Studies in this industry of various segments of the physical distribution system have been made. This thesis will look at physical distribution as a unit, i.e., not order processing by itself, but order processing as a link in a system designed to see that the customer's order

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[1]Steel Service Center Institute, op. cit., p. 4.

is delivered at the right place at the right time. Centers must see the interrelationship of various physical distribution functions, and make sure that individuals working within the system see the overall needs.

Customer service is one aspect of physical distribution. It is the intent of the physical distribution system to achieve a desired customer service level at the lowest cost possible. Many Centers operate on a very small profit margin. A return of six per cent on net profit before taxes is considered very good in this industry. Profits shrink when physical distribution is inefficient and costly. This research focuses on areas wherein physical distribution economies can be realized.

Specifically, then, the present research is designed to analyze physical distribution patterns in the Metals Service Center industry. This study is important because it is aimed at improving physical distribution of the Metal Service Center. This is not only each Center's major competitive weapon, it bears directly on the Center's economic effectiveness.

Stating the purpose of the research in problem form it is to: (1) determine those physical distribution activities undertaken by Metal Service Centers to make sure that the customer's order is delivered on time; (2) build a maximum performance model of physical distribution in this industry; (3) determine if large or small Centers

come closer to the maximum performance model; (4) determine if more profitable or less profitable Centers come closer to the maximum performance model; (5) compare differences of opinion regarding customer service among those holding different jobs within the Center; and (6) determine those physical distribution areas wherein improvements can be made, and which provide fruitful areas for future research.

General Research Design[1]

The overall aim is to construct a maximum performance model of physical distribution patterns in the Metals Service Center industry, to develop actual data regarding the existing patterns in this industry, and then to make a comparison between what should be and what is. The second part of the research is intended to evaluate differences of opinion regarding customer service among those holding different jobs within the Center.

Initially the problem was to develop an approach for securing information about physical distribution patterns in the Metals Service Center industry. The first method considered was the use of a mail questionnaire to cover the entire population of Centers throughout the United States; this extensive mail questionnaire would then be backed up by several relatively short personal interviews. The second method considered was to select a few

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[1]Detailed coverage can be found in Chapter 3.

representative Centers and to carry out extensive personal interviews with each one. The latter method was selected.

The next decision had to do with the number of Centers to be sampled. Enough sample Centers were required in order to make the sample representative with respect to size, geographic location and type of product carried. It was felt that the research would be most meaningful if it included as many Centers as possible; however, time and expense were factors working to keep the number down.

A review of the needs of the research was carried out and related to the categories of Centers which should be covered. It was felt that this research should cover most geographic areas in the country, study both large and small Centers, sample Centers carrying various types of products and include single-Center operations and multi-branch Centers. Twenty-four Centers were selected to be sampled, because it was felt that this number would give the research the representativeness desired. Any number less than 24 would have omitted a necessary element. It was assumed that any number in excess of 24 would have added information, but this additional information would have involved too much extra time and expense.

These 24 Centers are located in seven geographic areas: New England, Mid-Atlantic, Mid-West, Ohio Valley,

South, Southwest and Far West. Three Centers were selected from the Mid-Atlantic, South, and Far West, five were selected from the Mid-West and two from the Ohio Valley and the Southwest.

From these regions, Centers were selected so as to provide Centers of various sizes. Thirteen Centers with sales of $10 million or more and 11 with sales of less than $10 million were selected. Thirteen single plant Centers were selected and 11 Centers from multiple plant companies.

Size selection was weighted with product variety. The study included the general line carbon steel Centers and specialized Centers handling a more limited line. Specialized products included uncoated carbon steel sheets, stainless steel and alloy bars, carbon steel tubing, aluminum and stainless steel, cold rolled steel and precision ground and chrome plated precision shafting.

Once the number of Centers to be visited and their locations had been determined, the next step was the development of instruments which would be used to collect the data. Instruments were developed to gather information from three separate areas: (1) data about the characteristics of the Center; (2) data about the physical distribution activities of the Center; (3) data about attitudes toward customer service by various job

classifications within the Center. Examples of these instruments can be found in Appendix A.

The first instrument developed was the company "Data Sheet". This was sent out to each of the respondents two weeks prior to the visit and was included with a letter of introduction. This instrument was mainly designed to secure answers to questions about the general organization and operation of the Center. "Data Sheets" asked questions regarding such areas as Net Sales, and were used to classify the Centers on relevant variables and to familiarize the interviewer with the Center prior to the personal interview.

A personal interview schedule was the next instrument developed. By the use of this instrument a pattern was set up for the interviews, insuring coverage of topics and consistency from interview to interview. In basic design, the personal interview schedule was divided into six major sections. Each of the six sections was designed to cover the order from pre-receipt planning to customer delivery. Section I comprises general overall questions best answered by a company officer. Section II contains questions covering the order processing activities. Section III relates to problems of warehouse and transportation scheduling. Warehouse design, methods and operations are covered in Sections IV and V. The final section deals with the areas of transportation.

The third data gathering instrument used was the "Internal Questionnaire". In this instrument the questions asked relate to customer service and how the respondent's Center compares with competitors in the area of service. Identical questionnaires were given to four or five job groups within the Center. The general purpose was to obtain the respondent's feeling about the adequacy of the Center in the area of customer service.

Each Center was given four copies of the "Internal Questionnaire," or five copies if they had a traffic department. One copy each went to the inside salesman, outside salesman, warehouse manager and a company officer. "Internal Questionnaires" were left with the president for distribution and were to be mailed back to the writer upon completion.

Once the three instruments were developed, the Steel Service Center Institute arranged with a Center on the east coast to act as a test Center. All three instruments were pre-tested, and revisions were made based on the results.

A planned schedule of visits to all areas was set up. Several weeks prior to the proposed visit, the Steel Service Center Institute sent letters to the various Centers apprising them of the study and asking for their cooperation (See Appendix A). Shortly after the letter from the Steel Service Center Institute was sent, a

letter was mailed to the Center requesting permission to conduct a personal interview on a specified date. This letter also contained the company "Data Sheet" which the Center was requested to fill out and return.

Personal interviews were arranged on the basis of one full day for each interview. Such an arrangement worked out reasonably well. A full day was adequate in most cases; however, there were a few interviews which did not require the complete day and others where one day was not long enough.

Interviews began with the company executive who answered the broad overall questions relative to physical distribution. After the session with the company executive, the next step involved inside sales. When the interview was completed with the inside sales department, the next step was to carry the interview out to the warehouse. In the warehouse, interviews included the warehouse manager, shipping clerk and traffic manager, if there was one. Sometime during the warehouse interview, a tour was made of the warehouse itself.

Directly after these interviews, a report was written summarizing the physical distribution patterns of the Center visited that day. Thus, from the three basic instruments, an all day interview, and a written report on each Center have evolved the data which are the bases of this thesis.

Presentation of Material

Chapter II is concerned with physical distribution management. This chapter includes a working definition of physical distribution, a brief history of the physical distribution concept and a review of the basic function of physical distribution. In Chapter III a detailed description of the research design is presented. In Chapter IV the maximum performance physical distribution model is described. Chapter V contains the statistical analysis of the findings broken down according to size and profit. In Chapter VI the findings on the attitudes toward customer service among those holding different jobs within the Center are presented. Conclusions and recommendations are given in Chapter VII.

CHAPTER II

PHYSICAL DISTRIBUTION MANAGEMENT

Physical Distribution Defined

The National Council of Physical Distribution Management has broadly defined physical distribution as:

> A term employed in manufacturing and commerce to describe the broad range of activities concerned with efficient movement of finished products from the end of the production line to the consumer, and in some cases includes the movement of raw materials from the source of supply to the beginning of the production line. These activities include freight transportation, warehousing, materials handling, protective packaging, inventory control, plant and warehouse site selection, order processing, market forecasting and customer service.[1]

According to Bowersox, Smykay and Lalonde, "Physical distribution management is defined as that responsibility to design and administer systems to control raw material and finished goods flow."[2] To some people, physical distribution "refers to that portion of a

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[1]National Council of Physical Distribution Management, Executive Offices, 307 N. Michigan Avenue, Chicago, Illinois.

[2]Donald J. Bowersox, Edward W. Smykay and Bernard J. LaLonde, Physical Distribution Management (New York: The Macmillan Company, 1968), p. 5.

logistics system concerned with the outward movement of products from the seller to the customer or consumer."[1]

Charles Taff defines physical distribution as "the management of movement, inventory control, protection, and storage of raw materials and processed or finished goods to and from the production line."[2] The American Marketing Association defined physical distribution as "the movement and handling of goods from the point of production to the point of consumption or use."[3]

Some view physical distribution management as part of a larger concept, business logistics. Business logistics has been defined as "the management of all activities which facilitate movement and the coordination of supply and demand in the creation of time and place utility in goods."[4] Another definition of business logistics is

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[1]John F. Magee, Physical Distribution Systems (New York: McGraw-Hill, Inc., 1967), p. 2.

[2]Charles A. Taff, Management of Traffic and Physical Distribution (4th ed.; Homewood, Illinois: Richard D. Irwin, Inc., 1968), p. 6.

[3]Definitions Committe of the American Marketing Association, "1948 Report," The Journal of Marketing, (October, 1948), p. 202.

[4]J. L. Heskett, Robert M. Ivie and Nicholas A. Glaskowsky, Jr., Business Logistics (New York: The Ronald Press Company, 1964), p. 21.

that it "is the process inherent in a distribution system that moves materials and products from their producer to their consumer."[1]

Logistics is defined as "the science concerned with the logical arrangements of the functional areas required to achieve a desired goal. Thus, the logistics of distribution systems is the science concerned with the logical conceptual arrangement of the movement system facilities in such a way that a given desired goal is attained."[2] Logistics has also been defined as "the act of managing the flow of materials and products from source to user."[3]

Under a business logistics approach, the supply or inbound distribution system is often called "Materials Management." Dean S. Ammer says that materials management would embrace all activities conerned with materials except those directly concerned with designing or manufacturing the product. He includes purchasing, control, traffic, shipping, receiving and stores.[4] Materials

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[1]David McConaughy, ed., Readings in Business Logistics, (Homewood, Illinois: Richard D. Irwin, 1967).

[2]Frank H. Mossman and Newton Morton, Logistics of Distribution Systems (Boston: Allyn and Bacon, Inc., 1965), p. 4.

[3]John F. Magee, Industrial Logistics, (New York: McGraw-Hill, 1968), p. 2.

[4]Dean S. Ammer, Material Management (rev. ed., Homewood, Illinois: Richard D. Irwin, Inc., 1968), p. 12.

management covers all phases of the logistics of supply and acquisition.[1] Materials management is referred to by others as physical supply. Physical supply has been defined as "the portion of a logistics system concerned with the inward movement of materials or products from source to buyer."[2]

To further complicate the semantic problem, there are other terms and definitions. "Rhochromatics" has been called a scientific approach to the management of material flows."[3] "Marketing Logistics" attempts to tie together several of the related aspects of the administration of the economic firm, more specifically promotion and logistics.[4]

While there are many different definitions of physical distribution and several varied ideas as to what it covers, there is concensus on the fact that physical distribution is

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[1]Paul T. McElhiney and Robert I Cook, The Logistics of Materials Management (Boston: Houghton Mifflin Company, 1969), p. v.

[2]Magee, Industrial Logistics, op. cit., p. 2.

[3]Stanley H. Brewer, Rhochromatics, A Scientific Approach to the Management of Material Flows (Seattle, Washington: Bureau of Business Research, University of Washington, 1960), p. 3.

[4]Norton E. Marks and Robert Martin Taylor, eds., Marketing Logistics (New York: John Wiley & Sons, Inc., 1967), p. ix.

concerned with having orchids at the university flower shop the day of the homecoming dance and not in Hawaii. It is concerned with having steel at the customer's receiving dock when he wants it, at the lowest total cost possible.

In this thesis physical distribution is assumed to mean the design and administration of systems controlling the flow of both finished goods and raw materials.[1]

Objectives of a Physical Distribution System

Once the definition of physical distribution is established, it then becomes a problem to set forth objectives of physical distribution. What should guide managers in designing and administering systems controlling finished goods and raw materials flow? The objective of a good physical distribution system should be the meeting of the stated corporate customer service policy at the lowest total cost.[2] This objective is achieved by a balance of cost and service because "no physical distribution system can simultaneously maximize customer service and minimize distribution cost."[3]

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[1]Bowersox, Smykay and LaLonde, op. cit., p. 5.

[2]Ibid., p. 113.

[3]Philip Kotler, Marketing Management (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1967), p. 420.

These objectives of physical distribution are difficult to achieve because it is hard to develop accurate customer service standards and precise cost figures. Service standards are measured in time consumed from the point at which the order is placed until the order is delivered to the customer. Measuring just what the customer requires in the way of service is difficult because the customer will often ask for the highest level of service and be willing to settle for something a little less. Service is difficult, also, because there are other variables to consider besides time, e.g., dependability, communications and convenience.[1]

Given a required level of customer service, then, the physical distribution system should attempt to meet that service date at the lowest total cost. All physical distribution costs must be looked at together and combined to achieve the lowest overall cost. This total cost approach is different from the old system wherein an attempt was made to minimize costs in each functional area. Under the old system, it was possible to raise total cost by minimizing costs in one area, e.g., the selection of rail transportation might lower transportation costs, but increase inventory cost and warehouse cost.[2]

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[1]John F. Gustafson and Raymond Richard, "Customer Service in Physical Distribution," Transportation and Distribution Management, (April, 1964), pp. 19-23.

[2]United Air Lines Profit Analyzer (Chicago: United Air Lines, Inc., 1961).

It is necessary, under a total cost approach, to know all of the costs of physical distribution. Not all firms have this information and the accuracy of those costs that are available is sometimes questionable.

In the present research an assumption is made that the objective of physical distribution is the achievement of a desired level of customer service at the lowest total cost.

History of Physical Distribution

Early Development

Around the turn of the twentieth century, the United States shifted from an agrarian economy to an industrial economy. With this came widespread mass production. Distribution problems began to take on major significance as large manufacturers replaced wholesalers as dominant factors in the distribution of goods. As distribution became more important and problems grew, there emerged a number of books and articles on the marketing function.[1]

These early writers tended to equate physical distribution mostly with transportation and storage.

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[1]The material on the development of Physical Distribution is based on an article by Bernard J. LaLonde and Leslie M. Dawson, "Early Development of Physical Distribution Thought," in Bowersox, LaLonde and Smykay, eds., Readings in Physical Distribution (New York: The Macmillan Company, 1969), p. 9.

> The early 'principles' texts of the 1920's generally covered the physical distribution area in a section or chapter on 'transportation.' Gradually, however, as the task of distributing an increasing amount of differentiated products to regional and national markets grew, greater recognition was given to the deeper strategic implications of physical distribution.[1]

Some of the early pioneers in this area were Arch W. Shaw, Paul Cherington, Fred E. Clark and Theodore N. Beckman.

In the latter 1920's, Ralph Borsodi began to look into the costs of physical distribution. Borsodi said in 1927 that, "The day is gone when the recipe for fabulous profit was simply production, more production and still more production. The golden age of production is past. The age of distribution is upon us."[2]

In 1929, Richard Webster wrote an article entitled, "Careless Physical Distribution: A Monkey Wrench in Sales Machinery."[3] Webster talked about coordinating such activities as plant location, warehousing, freight rates, packaging and inventory control. Other authors in the

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[1]Bernard J. LaLonde and Leslie M. Dawson, "Pioneers in Distribution," Transportation and Distribution Management, (June, 1969).

[2]Ralph Borsodi, The Distribution Age (New York: D. Appleton & Company, 1929), p. 3.

[3]Richard Webster, "Careless Physical Distribution: A Monkey Wrench in Sales Machinery," Sales Management, Vol. XIX (July 6, 1929), p. 21.

late 1920's and early 1930's were looking at the integrative nature of the physical distribution activities. Ralph Breyer[1] and Paul Converse[2] were two of the major contributors during this period.

The literature was somewhat muted in the area of physical distribution during the depression and World War II periods. While World War II may have been a period of limited writing, the physical distribution problems overcome by the United States in World War II were significant. Integration of physical distribution activities was necessary during the war in order to carry on a military conflict in both Europe and Asia.

Growth of Physical Distribution

After the second World War, interest developed in marketing. There was a tremendous growth in the product line of many companies. The "marketing concept" was developed which turned the focus of the firm to the customer. "The 'marketing concept' involves, among other things, a consumer-oriented approach to marketing . . ."[3]

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[1]Ralph F. Breyer, The Marketing Institution (McGraw-Hill Book Company, 1934).

[2]Paul D. Converse, Selling Policies (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1927).

[3]Charles F. Phillips and Delbert J. Duncan, Marketing Principles and Methods (6th ed.: Homewood, Illinois: Richard D. Irwin, Inc., 1968), p. 56.

Market segmentation began to take place. "Market segmentation consists of viewing a heterogeneous market as a number of smaller homogeneous markets in response to differing product preferences among important market segments."[1] Instead of producting one black telephone and using advertising to capture various tastes, multi-colored telephones in various styles were produced.

Market segmentation means that more items are in inventory with attendant increases in the cost of carrying inventory and with the need for efficient inventory management. Distribution centers must carry wider lines of products. Selection in the distribution center becomes more difficult. Transportation problems are increased by the necessity for consolidating many different products. Order processing problems increase because the order is not for ten items of "A", but is for one item of "A", one of "B", and one of "C", etc. Wider product lines cause changes in packaging and require variations in material handling equipment.

In the late 1950's, many business organizations were confronted with a cost-profit squeeze. Costs were increasing faster than revenues and the opportunity for economies in production were limited. Under the

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[1]Wendell R. Smith, "Product Differentiation and Market Segmentation As Alternative Marketing Strategies," in The Environment of Marketing Behavior, ed. by Holloway and Hancock (New York: John Wiley and Sons, 1964), p. 305.

functional approach to distribution, each area was managed separately and costs were high. Management began to realize that the profit-cost squeeze might be alleviated by more effective physical distribution management.

It was also during the late 1950's that great advances were made in automated data processing equipment. Physical distribution management entails the integration of many functions. All functions must work together in order to achieve the lowest total cost consistent with good customer service requirements. This sounds very good; however, a man with a pad and pencil can hardly work out all of the possible combinations. Multivariate problems, previously too complex to handle, are easily solved with the computer. The capabilities and potential of the computer fit the requirements of physical distribution very nicely. Along with the development of automatic data processing equipment came the systems approach to management. Under the systems approach, the firm maximizes profit by analyzing all components of the business enterprise and the interaction of these components upon one another.[1]

Other major factors during the 1950's and early 1960's which helped the growth of the physical distribution concept were: (1) changes in customer demand patterns in

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[1]Charles A. Taff, Management of Traffic and Physical Distribution (4th ed.; Homewood, Illinois: Richard D. Irwin, Inc., 1968), p. 4.

terms of location; (2) increased competition both domestic and foreign; and, (3) the impact of the trend toward conglomerate mergers on procurement and distribution systems.[1]

Physical Distribution in Maturity

Physical distribution began to get recognition in the early part of the twentieth century in the marketing text books. The focus of attention of this early period was on the distribution of commodities and its role as a marketing function. The individual elements which make up physical distribution as we know it today were around, but there was no extensive treatment of all of the elements as a unit.

During the 1950's and early 1960's, the functional areas of physical distribution were integrated, and the concept of a physical distribution system came into being. It is not, then, that physical distribution has actually grown out of marketing or traffic management;[2] rather it

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[1]Lewis M. Schneider, "Milestones on the Road of Physical Distribution," Reflections on Progress in Marketing, American Marketing Association (December, 1964), pp. 395-396.

[2]In Charles Taff's original book on traffic management, the author defines traffic management as "the myriad aspects of the purchase of transportation and transportation service by shippers or consignees, . . ., which will include the use of facilities and equipment at a price or rate consistent with the services rendered in order to effect the efficient movement of persons and property from one point to another."

has been a regrouping of many related functions to form a new whole, physical distribution. Many traffic management educators were significantly involved in the growth of the physical distribution concept, but the real leadership came from the industry buyers and suppliers of transportation.[1]

Physical distribution is in a period of refinement. "The years since 1965 have been characterized by a refinement in basic concepts and a development of greater precision in the tools of analysis."[2] The base has been set, physical distribution must now grow and develop from that base.

Physical Distribution Functions

It is difficult to specify exactly what functions should be included under physical distribution because each firm has a different set of functions in its physical distribution department. There are differences here, some of which are related to the different definitions of physical distribution. Some of the areas that might be included in physical distribution are: transportation,

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[1]Donald J. Bowersox, "Physical Distribtuion in Semi-Maturity," Air Transportation, (January, 1966), pp. 9-11.

[2]Donald J. Bowersox, "Physical Distribution Development, Current Status and Potential," in Readings in Physical Distribution Management ed. by Donald J. Bowersox, Bernard J. LaLonde and Edward W. Smykay (New York: The Macmillan Company, 1969), p. 368.

inventory control, warehousing, materials handling, packaging, site selection, order processing, and information systems.

Transportation

This is the area wherein the traffic manager has traditionally been in managerial control. Traffic managers generally have control over the actual movement of people and material. They are responsible for the planning, direction, selection, procurement and use by the organization of all the aspects of transportation.[1] Traffic management started as a specialized aspect of purchasing.[2] Some of the more specific functions included here are the procurement of all transportation and the management and operation of private transportation fleets.

Perhaps the greatest emphasis in transportation is on the movement of freight; however, the movement of people is also very important. Effectively handling a household goods movement or making the transportation aspects of the annual meeting come off smoothly can lead to greater confidence in the distribution department and pay dividends in later freight movement progress.

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[1]Taff, op. cit., p. 9.

[2]Kenneth J. Flood, Traffic Management, (2nd ed.; Dubuque, Iowa: William C. Brown Company Publishers, 1963), p. 7.

Traffic managers also are the experts on the costs of transportation, and work with the carriers to get lower rates and better classification of items. They also audit transportation charges and file loss and damage claims against carriers. Traffic managers must be familiar with the legal aspects of transportation as well. This might include working with local commissions, or the Interstate Commerce Commission. Traffic managers should be the ones who know the legal obligations and restraints of transportation.

Another vital role of this department would be to control all shipments in the distribution pipeline. Activities here might include expediting and tracing of shipments, diversion or reconsignment of shipments, procurement of equipment, and establishing transportation contracts. In some companies, this department is often the authority on international shipments. Traffic managers also develop consolidations which lower distribtuion costs and improve service.

Inventory Control

"Inventories have their justification in terms of the extent to which they contribute to the effective overall operations and profitability of an organization."[1]

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[1]Norbert Lloyd Enrich, Inventory Management (San Francisco: Chandler Publishing Company, 1968), p. 11.

Inventory management has always been difficult from the firm's point of view. Sales has traditionally been interested in a high finished goods inventory; production and purchasing might like large raw material inventories; and, finance wants very little capital tied up in any kind of inventory. These issues of inter-department conflict must be solved for the overall good of the firm.[1]

Inventory management is defined as "the sum total of those activities necessary for the acquisition, storage, sale, disposal or use of material."[2] Primary among the problems of inventory management are the questions of what to order, when to order and in what quantity or volume to order.

What to order depends on good research as to what the market will demand. Not only is it important to know what the market will want, but the firm must generate information about the volume of each item, the customer purchasing the item, the critical-value of this item to the customer and the costs associated with being caught out of stock on a particular item. Inventory forms a buffer between production and sales and the effectiveness of any inventory management program depends

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[1] Ibid., p. xiii.

[2] James A. Pritchard and Robert H. Eagle, Modern Inventory Management (New York: John Wiley & Sons, Inc., 1965), p. 2.

largely on an ability to make some sort of reasonably accurate forecast of usage or sales. All inventory models depend on a forecast of sales.[1]

Stockouts are a major problem. When customer relations are damaged, the reputation of the firm as a dependable source of supply is harmed.[2] It is a very difficult matter to determine the probably cost of a lost sale or a lost account. In addition to stockout costs, there are other costs which affect inventory management. There are the costs associated with procuring the units of stock, costs of carrying the items in inventory, costs of filling customer orders and the cost of operating the data gathering and control procedures for the inventory system.[3] These costs must be balanced in order to achieve the lowest total cost.

Problems of when to order are related to the order cycle and forecasting requirements. Firms must know when the material will be required, how long it will be in

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[1]Joseph Buchan and Koenigsberg, Scientific Inventory Management (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1963), p. 28.

[2]James A. Constantin, Principles of Logistics Management (New York: Appleton-Century Crofts, 1966), p. 322.

[3]George Hadley and Whitin, Analysis of Inventory Systems (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1963), p. 10.

in transit, what length of time it takes to communicate the order and to process the order.

How much to order generally requires the balancing of the cost of ordering and the cost of carrying inventory. The most commonly used method here is the economic order quantity (EOQ).[1] Mathematically, this formula is usually expressed as:

$$EOQ = \sqrt{\frac{2\ as}{i}}$$

a = Ordering Cost per Order
s = Annual Sales Rate
i = Interest Cost per Unit per Year

The EOQ method is subject to many limitations, but it can serve as a foundation upon which a firm may develop more sophisticated systems.

Warehousing

Twenty or 30 years ago, warehousing was looked on as a necessary evil. Warehousing was basically a storage function which had goods held near the market prior to consumption. This was necessary because production and consumption were not coordinated.[2] Today the warehouse, or as it is more commonly known now, the distribution center,

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[1] Bowersox, Smykay and Lalonde, op. cit., p. 204.

[2] Fred Clark, Principles of Marketing (rev. ed.; New York: The Macmillan Company, 1932), p. 368.

emphasizes the movement of goods. Centers are placed strategically throughout the firm's market territory in order to facilitate the movement to the customer. Centers are added or deleted to achieve a lower distribution cost or gain better service.[1] The ideal system would find orders "being received, blended into customized orders, and shipped to the next node in the distribution channel without the goods coming to rest within the confines of the distribution center."[2]

"Delivery time has become an essential tool of marketing; frequently, providing shorter delivery time is used instead of lowering prices to attract the customer. This marketing technique is one of the main reasons why the field of warehousing is expanding so rapidly."[3]

The distribution center concept has made the warehousing function important in the physical distribution system. The problem is that sometimes obsolete methods are coupled with crowded conditions resulting in slower

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[1]Donald J. Bowersox, "The Distribution Center Location Problem," Houston Business Review, (Winter, 1965), p. 41.

[2]Norman E. Daniel and J. Richard Jones, Business Logistics: Concepts and Viewpoints (Boston: Allyn and Bacon, Inc., 1969), p. xi.

[3]Creed Jenkins, Modern Warehouse Management (New York: McGraw-Hill Book Company, 1968), p. 1.

materials movement and extra handling with attendant increases in operating expenses.[1]

John F. Magee lists eight major functions a warehouse performs:[2]

1. Receives Goods
2. Identifies Goods
3. Sorts Goods
4. Dispatches Goods to Storage
5. Holds Goods
6. Recalls, Selects or Picks Goods
7. Marshalls the Shipment
8. Dispatches the Shipment

Some of the major problems which must be answered in order that these functions be carried out deal with the overall warehouse evaluation and requirements, warehouse construction and finance which includes site selection, construction cost factors and facility design factors; warehouse layout, efficiencies in operations including handling-time standards, space-utilization standards and performance control reports; evaluation, selection and maintenance of handling and storing equipment; the scheduling of operations such as receiving, processing, order picking and shipping; and, the development of cost and administrative controls.[3]

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[1]Andrew J. Briggs, Warehouse Operations, Planning and Management (New York: John Wiley & Sons, Inc., 1960), p. 1.

[2]John F. Magee, op. cit., p. 73.

[3]Jenkins, op. cit., p. v.

Problems related to site selection and materials handling are often included under separate categories. This is done because the difficulties connected with these two areas go beyond distribution warehousing. Site selection would go beyond the warehouse location and include also such factors as plant location. Likewise, problems of materials handling will go beyond the warehouse and would include movement in the plants and other areas.

Materials handling "embraces the basic operations in connection with the movement of bulk, packaged and individual products in a semi-solid or solid state by means of gravity-, manually- or power-actuated equipment and within the limits of an individual producing, fabricating, processing or service establishment."[1] Materials handling is moving things from one place to another and arises not by itself but within the context of a larger system.[2]

Packaging

Packaging is something every manufacturing firm does. It is difficult to say just where in the organization packaging lies. Packaging organization varies so greatly from

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[1]D. Oliphant Hayes, Materials Handling Equipment (Philadelphis, Pa.: Chilton Company, 1957), p. viii.

[2]William T. Morris, Analysis for Materials Handling Management (Homewood, Illinois: Richard D. Irwin, 1962), p. 3.

company to company that only a few accurate generalizations can be made. In some firms packaging is a part of the production operation; in other firms packaging is part of the marketing department, and in a majority of firms packaging falls somewhere between the two extremes.[1] Packaging may be defined as "the preparation of goods for shipment and marketing."[2]

It has been said that the first requirements of a packaging material are to insure complete protection of the contents.[3] A package must be based on an optimum combination of all the factors concerned with physical distribution. Some of these factors might be:[4]

Purchase Cost
Tare Weight
Cubic Displacement
Rates for Chosen Means of Transportation
Material Handling Cost
Warehousing Cost
Loss and Damage Expenses
Customer Convenience
Merchandising Appeal
Satisfaction of the Personal Prejudices That Are Encountered in Some Areas
Complete Conformance to Classification Regulations of the Carrier

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[1]Donald D. Deming, Company Organization for Packaging Efficiency (New York: American Foundation for Management Research, 1962), p. 8.

[2]Glossary of Packaging Terms (2nd ed.; New York: Packaging Institute, Inc., 1955), p. 187.

[3]Louis C. Boril, Packaging Engineering (New York: Reinhold Publishing Corporation, 1954).

[4]R. C. Colton and C. S. Ward, Practical Handbook of Industrial Traffic Management (Washington, D.C.: Traffic Service Corporation, 1965), p. 146.

There are many logistical concerns related to the package. Packages must conform to certain standards for transportation. A poorly designed package may cause high freight claims. Too much protection might lower claims costs, but raise transportation costs. The package must be designed for handling throughout the distribution system. Not only must the package be designed for easy handling, but also the package must allow for maximum unitization. A package with poor stacking strength will take up extra square feet in the warehouse.[1]

Physical distribution controls the packaging as it affects the distribution system. Physical distribution must work with the other departments concerned with packaging in order to make sure that the whole system gets the maximum output for its packaging dollar.

Order Processing and Information Systems

In an article entitled "Total Information Systems in Logistics," Donald J. Bowersox states that "the primary goal of a logistics system is to shorten the interval between impulse (an order for example) and response (delivery for example)."[2]

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[1]Walter F. Friedman, "The Role of Packaging in Physical Distribution," Transportation and Distribution Management, (February, 1968).

[2]Donald J. Bowersox, "Total Information Systems," Transportation and Distribution Management, (October, 1964), p. 325.

The order cycle system begins, then, when the customer's order is received. Time is just as much a factor in getting an order through the office to the warehouse as it is in the selection of a mode of transportation. Electronic data processing and improved telephone facilities such as "Data-Phone" and WATS (Wide Area Telephone Service) have been used in recent years to help speed the flow in information. An on-line order entry system, complete with credit check, can be accomplished in a matter of seconds with the use of the IBM 360 Computer.

Some of the more common functions of order processing, according to Robert M. Ivie,[1] are to: (1) complete order forms; (2) keep those concerned, including both customer and salesman, informed; (3) make the order or copies of it available to other areas of the firm such as marketing, finance, accounting and purchasing; (4) coordinate with the credit department on order clearance; (5) communicate the order to the shipping point without delay; (6) update inventory control records and namufacturing or purchasing schedules.

Information systems can be defined as "an integrated corporate intelligence system designed to permit

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[1]Robert M. Ivie, "Information Systems for Logistics Management," Paper presented at The Third Annual Meeting, 1962, Transportation Research Forum.

management by exception, based on timely information, randomly available and guided by rigorously determined relationships and decision rules."[1] One author says that there are three major information systems within the firm, logistics, finance and personnel and some minor systems. He says that "the logistics system is concerned with information about the physical flow of goods through an organization."[2]

There has been a distinction made between external and internal information systems. Internal is related to information between functional departments within the organization and external deals with information about supplier and customers.[3] Good information systems provide the information necessary "to offer alternative choices as a basis for decision making to operate economically and efficiently and to plan for the future."[4]

These are the major functions of physical distribution. The extent of importance, use and coordination of

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[1]Roger Christian, "The Total Systems Concept," from a speech delivered before the 14th Annual International Systems Meeting, October, 1961, p. 8.

[2]John Dearden, "How to Organize Information Systems," Harvard Business Review, (March-April, 1965).

[3]Ivie, op. cit.

[4]Elmer B. Staats, "Information Systems in an Era of Change," Financial Executive, (December, 1967), p. 39.

these functions depends on the particular product being distributed. One of the major product this thesis covers is steel.

Physical Distribution of Steel

The first physical distribution problem in the steel industry is the movement of the raw material from the mine to the mill. This is a major factor in the steel industry since the end product is the result of the combination and processing of these raw materials. Coal, iron ore and limestone are the major raw materials, and they must move to the steel production centers in the most efficient manner possible.[1]

At the mill, the raw materials are processed, and combined with scrap steel to make ingots. The ingots are generally rolled, cut, further processed and packaged, in some cases, before the final product is ready for shipment. From the mills, the steel is distributed to various markets. Seventeen and one-half per cent of the domestic tonnage in 1968 went to Metal Service Centers.[2] Other major markets include the automotive market which generally takes about 22 per cent· the construction market 13 per cent; the container market with 9 per cent; the

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[1]Elliot Youngberg, "The Changing Logistics of Steel," In Business Logistics in American Industry, ed. by Ruppenthal and McKinnell (Stanford, California: Stanford University, 1968), p. 261.

[2]Steel Service Center Institute, 1969-1970 Roster of Members, op. cit., p. 4.

machinery, industrial tool and equipment market six per cent; and, the domestic appliance and commercial equipment market six per cent.[1]

Once into these markets, the steel is further processed and usually becomes part of another product. Steel is mixed with other materials to form automobiles, buildings, bridges, telephone switchboards and other products. The exception to the above process is the 17 and one-half per cent which goes through Service Centers. Here the Center acts as an intermediary in the movement to the final consumer. As was pointed out in Chapter I, Centers perform the "break-bulk" function, do some first production processing, and reduce the final customer's cost of possession.

The distribution of steel from mine to consumer is depicted in Figure 1. The chart in Figure 1 could also depict various channels of distribution. There is the channel for the raw material, for the steel and for the finished goods. As mentioned before, Metal Service Centers account for 17 and one-half per cent of total distribution of steel. A channel has been described as, "Any sequence of marketing institutions, from producer

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[1]The Making of Steel (New York: American Iron and Steel Institute, 1964), p. 13.

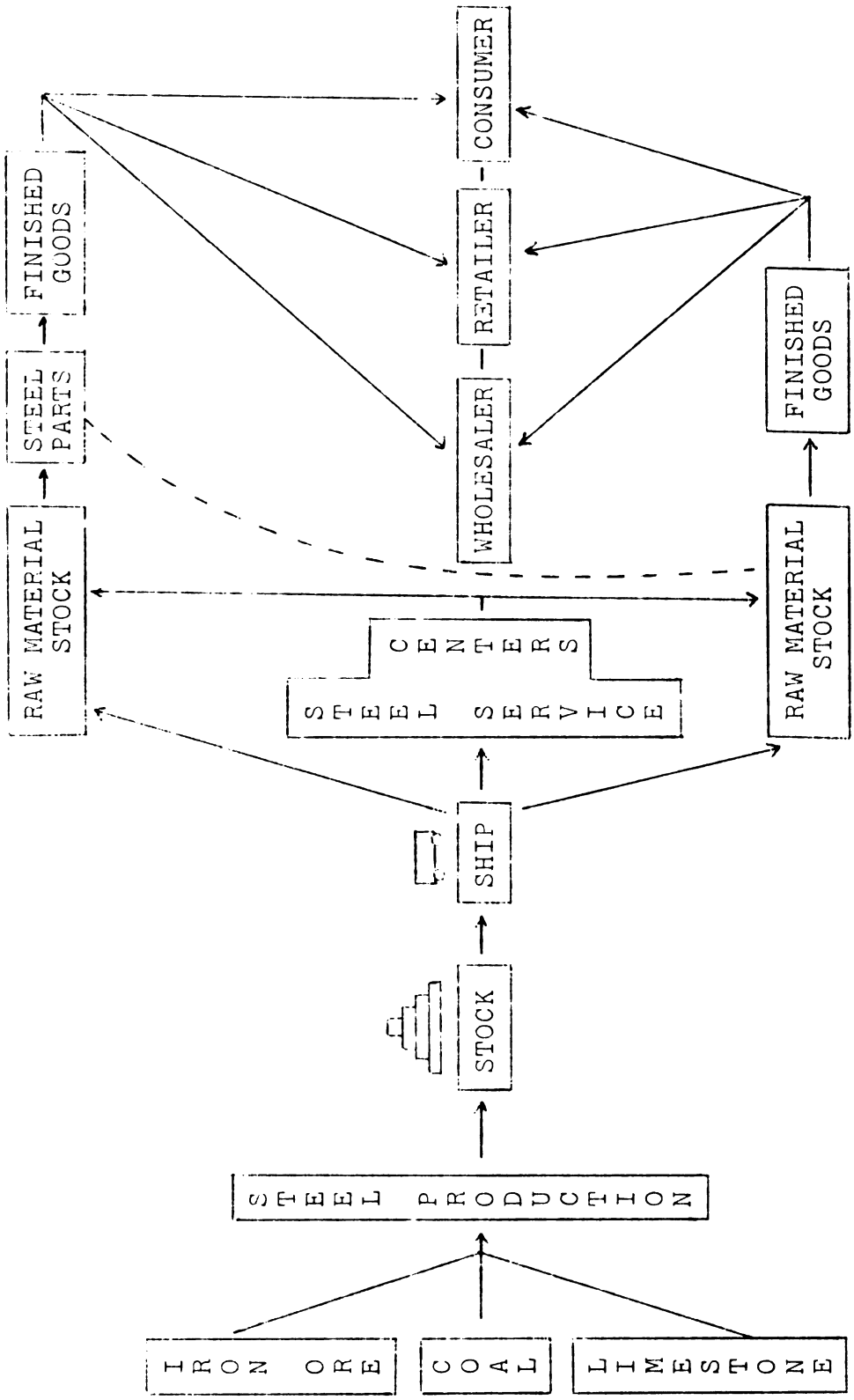

Figure 1.--Distribution of Steel from the Mine to the Customer.

to final user or consumer, including any number of middlemen."[1] A channel of distribution is concerned with the flow of goods from the producer to the consumer.

According to Ralph Breyer, in the very broad sense, channels of distribution include trading concerns engaged in buying and selling, such as producers, wholesalers and retailers, and non-trading concerns. Some non-trading concerns might be commercial banks, insurance companies and transportation companies.[2]

A concept related to the trading and non-trading concerns is the idea of an exchange channel and a transaction channel. Those in the transaction channel engage in trading. The intermediaries in the exchange channel are engaged in the functions of physical movement. This differs from Breyer's concept in that his trading and non-trading channels could both engage in exchange.[3]

A channel of distribution has traditionally been looked upon as a series of independent agencies, usually in the trading category. Recently there has been emphasis

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[1]E. Jerome McCarthy, Basic Marketing (3rd ed.; Homewood, Illinois: Richard D. Irwin, Inc., 1968), p. 312.

[2]Ralph F. Breyer, "Some Observations on Structural Formation and the Growth of Marketing Channels," in The Marketing Channel, ed. by Bruce E. Mallen (New York: John Wiley & Sons, Inc., 1967), p. 20.

[3]Donald J. Bowersox, Changing Channels in the Physical Distribution of Finished Goods," in Readings in Physical Distribution Management, ed. by Bowersox, LaLonde and Smykay (New York: The Macmillan Company, 1969), p. 94.

placed on looking at the channel as a complete unit. Louis Stern feels that " . . . The distribution channel, as a whole, can be conceived of as a competitive unit in and of itself, for the success of a product carried by a channel is largely determined by the effectiveness with which resources have been mobilized throughout the entire interfirm network."[1]

While there is a total unification apporach to the study of channels of distribution, and there is the relationship of the physical distribution activities of various intermediaries, this thesis will be concerned with one part of a total channel of distribution--The Metal Service Center.

The major emphasis of this study will be on the Service Centers' outbound physical distribution activities. Purchasing, demand forecasting, inbound transportation, and receiving practices will not be covered in depth because of a time constraint and a desire to cover outbound patterns more fully. Inventory control is not covered to any extent. Inventory control is an extremely important activity in the Center; however, this area was treated in a recent study by John Demaree,[2] and in a

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[1]Louis W. Stern, Distribution Channels: Behavioral Dimensions (Boston: Houghton Mifflin Company, 1969), p. 1.

[2]John D. Demaree, "Inventory Management--Positive and Normative Models of Decision-Making in the Metals Service Center Industry" (unpublished Ph.D. dissertation, Graduate School of Business Administration, Michigan State University, 1964).

subsequent book by Claude McMillan and John Demaree.[1] Coverage here would be repetitious and unnecessary. Location theory is not covered either, although this too is an important part of physical distribution. It can be noted that transportation has changed the distribution patterns in this industry. After World War II many Centers built market-positioned distribution centers, because traffic congestion slowed truck delivery. The development of the interstate highway system reversed this trend. Many plants were closed when companies found they could economically supply those areas from a central plant.

This study will cover physical distribution patterns for Metal Service Centers beginning at the time the order is received and ending when customer delivery is satisfactorily accomplished. This is a portion of the total distribution which begins when the raw material is mined and ends when the customer purchases his new metal product.

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[1]Claude McMillan and John Demaree, The Management of Metal Inventories (Cleveland, Ohio: The Steel Service Center Institute, 1967).

CHAPTER III

RESEARCH DESIGN AND SAMPLE

The general objective of this research was to develop useful information about physical distribution patterns in the Metals Service Center industry. To accomplish this, three specific objectives were set: (1) To build a maximum performance model of physical distribution based on the present body of knowledge in the field, plus the peculiarities of physical distribution as they exist among Metals Service Centers. (2) To check empirically the extent to which operative Centers approximate the model, especially whether size and profitability are correlates of physical distribution effectiveness. (3) To find the degree of concensus which exists among various job holders with respect to customer services involved in physical distribution.

Achievement of the first objective, construction of a maximum performance model, involved a thorough literature search, numerous informal discussions with faculty familiar with this industry, plus visits to five Centers in the Michigan area.

As a by-product of the model building it seemed evident that size and profitability might be expected to

bear on distribution effectiveness. The second objective, empirical checking of data against the model, involved drawing an appropriate sample, field data collection from the 24 Centers included, and analysis of the data in terms of the model.

Achievement of the third objective, degree of consensus among personnel with regard to customer services, required the same steps as the second objective.

Definition of the Problem

In developing good problems, three criteria should be followed: (1) problems should express a relationship between two variables; (2) problems should be stated in question form; and, (3) problem statements should be of such a nature as to suggest methods of empirically testing.[1]

Given the basic industrial structure of the Metal Service Center industry, the problems under research in this thesis are: Does size affect the Centers' physical distribution patterns? Do high profit Centers have better physical distribution systems than low profit Centers? Does the job an individual performs in the Center affect his attitude toward customer service?

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[1]Fred N. Kerlinger, Foundations of Behavioral Research (New York: Holt, Rinehart and Winston, Inc., 1965), p. 19.

This research is designed to ascertain the answers to these three basic problems. Because problems cannot be scientifically solved, they must be expressed in hypothesis form. Problems and hypotheses are closely related; however, hypotheses, when properly stated can be tested. The following section outlines the hypotheses used in this thesis.

Specific Statement of the Hypothesis

A hypothesis is defined as, "a tentative assumption made in order to draw out and test its logical or empirical consequences."[1] Hypotheses are a vital and important part of research. Hypotheses are important because they are the working instruments of theory. Also, hypotheses can be tested and "enable man to get outside himself."[2] "A problem really cannot be scientifically solved if it is not reduced to hypothesis form because a problem is a question, usually of a broad nature, and is, in and of itself, not directly testable."[3] Through a hypothesis, research achieves direction; problems can be solved and the premises underlying these problems can either be supported or not supported.

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[1] Webster's Seventh New Collegiate Dictionary (Springfield, Mass: G. and C. Merriam Company, 1963), p. 410.

[2] Kerlinger, op. cit., p. 22.

[3] Ibid., p. 23.

This research is structured to test the following null hypotheses.

Hypothesis 1: No differences exist between Metal Service Centers of different size groups and the maximum performance physical distribution model.

Hypothesis 2: No differences exist between Metal Service Centers of various profit classifications and the maximum performance physical distribution model.

Hypothesis 3: No differences of opinion exist regarding customer service among those holding different jobs within the Metal Service Center.

Physical Distribution Model

The physical distribution model to be used in this thesis is a verbal, maximum performance model. This model is verbal because the variables and their relationships are described in prose rather than mathematically. It is a maximum performance model because it purports to show how things should be in physical distribution under ideal conditions rather than describing things as they actually are.

There are three parts to the model based on three sub-sections of the Center's physical distribution system. The first part of the model covers the inside sales activities. Each major activity which takes place during the

period from when the order is received until it is sent to the warehouse is described in prose according to how this activity should be carried out. The other two areas covered are the warehouse and transportation. The warehouse sections cover those activities from when the order is received in the warehouse until it is shipped. Transportation covers all those activities which must be carried out in delivering the order.

Conduct of the Research

Survey research is a branch of investigation that studies large and small populations by selecting and studying samples chosen from the population to discover the relative incidence, distribution and interrelationships of variables.[1] Survey methods are generally classified as: personal interview, mail questionnaire, panel, telephone and controlled observation.[2] Of these, the personal interview and mail questionnaire seemed most appropriate for the present research. The latter was eliminated because in order to cover the total physical distribution system, mail questionnaires would have to have been rather lengthy. This would have increased the lack of response and made the job of analyzing the responses furnished more difficult. Poor response would have

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[1] Kerlinger, op. cit., p. 393.

[2] Ibid., p. 397.

made it impossible to make valid generalizations. The use of the mail questionnaire would limit the amount of personal observation of such things as warehouse design or congestion on the shipping dock which were believed to be a necessary part of this study.

Personal interviews with a limited number of Centers was finally selected as the data collecting method. Personal interviews would provide for detailed observations, clarifications of questions, probing into weak areas, finding the proper person to answer each of the questions. It was felt tht the personal interview would provide the maximum amount of information and allow for flexibility in individual situations.

Data gathering for the second part of the study dealing with attitudes toward customer service by various job holders within the Center was handled through a questionnaire. The questions asked were short, direct and required no explanations or probing. It was felt that response would be good if these questionnaires were left with one of the Center's top managers for distribution to the appropriate personnel at the time of the personal interview.

Instrument Development

Three instruments were developed in order to gather data for this thesis, the company data sheet, a personal interview schedule, and internal questionnaire (see

Appendix A). The company data sheet was a short two page questionnaire which was set up to provide some basic information about the Center prior to the personal interview. Data sheets contained questions about the Center's product line, profit, number of employees, and markets. The data sheet not only provided background information about the Center, it also provided the information which allowed Centers to be categorized and provided more personal interview time for questions about physical distribution because routine company information questions had already been asked.

Personal interview schedules were set up in six sections: company officer, order processing, scheduling, selecting, packing and shipping and transportation. The company officer was placed first so that the interviewer could introduce himself to the Center's top management and help to assure cooperation throughout the Center. In addition, the company officer was asked questions which might be considered classified, for example, those dealing with costs and those which covered the complete operation, such as physical distribution policy.

The remainder of the schedule was arranged to cover three major areas: inside sales, which included all operations from receipt of the order until it goes to the warehouse; warehouse operation, which covered the order from the time when it arrived in the warehouse until it was

shipped; and, transportation, which covered fleet operation and maintenance, delivery scheduling, routing and transportation rates.

Internal questionnaires were the final data gathering instruments used. This questionnaire was designed to determine attitudes about the Center's ability to provide customer service and compete with other Centers in this area. Each Center was to have this instrument completed by a company executive, inside salesman, outside salesman, warehouse manager and traffic manager.

When these three instruments had been drafted, they were pre-tested at an eastern Center and revised where necessary.

Personal Interview Program

There were seven geographic areas which were to be samples: the Far West, Southwest, South, Mid-West, Ohio Valley, Mid-Atlantic and New England. Personal interview trips were scheduled to each of these areas. All but the Mid-West and Mid-Atlantic were to be covered in one trip. It would take two trips to cover the Mid-West; Mid-Atlantic trips were made individually.

Three weeks prior to the personal interview, a letter was mailed by Mr. Robert Welch, President of the Steel Service Center Institute, to the Centers selected to be interviewed (see Appendix A). This letter was the initial contact with the Center to be visited, and told the Center

something about the thesis, solicited cooperation and informed the recipient that he would be contacted shortly about an interview date.

A week after Mr. Welch's letter was sent, a letter was mailed to the Centers to be visited. This letter of introduction contained the company data sheet and a self-addressed envelope. In addition, it set up a specific date for the personal interview and asked if that date was acceptable.

Conduct of the Interviews

Letters of introduction specified the time that the interview was to begin. Interviews were set up to last the whole day from 9:00 A.M. until 5:00 P.M. Personal interviews began with a company officer, in many cases the president of the Center. This first phase of the interview lasted from one-half hour to an hour. During this period, the first part of the personal interview schedule was completed.

The next part of the interview took place with the inside sales manager. During this part of the interview, which lasted about two hours, all phases of order processing functions were covered. After lunch, the interview began with the warehouse manager. This interview lasted two hours, if the company had a traffic manager, and three if there was no traffic manager. During this portion of the interview, a tour of the warehouse was taken. If the

Center had a traffic manager, the final hour was spent with him.

Most interviews terminated with a return visit with the company officer, and sometimes other staff members. Answers were requested to questions which could not or would not be answered in the other areas. It was during this final session that the internal questionnaires were left with the company officer.

Response and Follow-Up

Response to the personal interview was 96 per cent successful, i.e., 96 per cent of the Centers interviewed answered all of the questions to the best of their ability. Not all of the questions were answered, because some Centers did not have the information. The four per cent answered some of the questions, but claimed some of the questions required a confidential answers, and failed to respond even though the information was available.

Two-thirds of the internal questionnaires were returned without a second request. For the other one-third, a follow-up letter was mailed about a month after the personal interview. In two cases, a third request for replies was sent out by Mr. Welch. Internal questionnaires were completed by all but one Center, which refused to circulate the questionnaire.

Sample Design

"Sampling is taking any portion of a population, or universe, as representative of that population or universe."[1] This portion of the population is then considered to be representative of the whole universe. It is best to use as large a sample as possible in order that the principle of randomization be allowed to work and that the sample be as closely representative of the population as possible.

At first it was thought that a sample of 11 Centers would be adequate. This figure was eventually expanded to 24. It was felt that 11 Centers would not provide enough variety in terms of product line, geographic location, profit and size, and that a sample of this size would not be representative of all Centers.

In the final analysis, it was determined that 24 Centers would be sampled. This number would allow for a good representation of Centers and yet still allow for detailed interviews with each Center. Additional samples beyond 24 were considered; however, it was felt that the time and cost of additional interviews was high when compared with the added information that might be obtained from the additional interviews.

The selection of the 24 Centers to be included in the survey was done in conjunction with the Steel Service

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[1]Kerlinger, op. cit., p. 52.

Center Institute. Since the members of the Institute have a long and extensive knowledge of the industry, it was felt that they could help make the sample representative. Twenty-four Centers were selected on a purposive basis so as to give the sample representativeness in terms of size, product and geography.

Center size varied from small, 20-man one-Center operations to large, thousand-man multi-Center operation. In the sample were 13 Centers in which sales were $10 million or more and 11 Centers with sales less than $10 million. Thirteen Centers were part of regional or national operations, while 11 were single Center operations. Ten Centers employed less than 100 people, and 14 Centers employed more than 100.

Centers comprising the sample were also selected based on the type of product sold. General line carbon steel Centers are the most prevalent type of Centers, so the largest number came from this class of Center. There were 14 general line carbon steel Centers in the sample. In addition, the sample included three Centers which specialized in steel plates or sheets; three Centers which specialized in aluminum or stainless steel; one Center specializing in carbon steel tubing; one Center specializing in stainless steel and alloy bars; one Center specializing in cold rolled steel; and, one Center specializing in chrome plated precision shafting.

Geographically, it was decided to attempt to cover as many different areas in the country as possible, and yet still retain some control over travel cost and time. Five Centers were selected from the Mid-West, which was the largest number selected in any area. This was justified because the Mid-West is the geographic center of power in this industry. Four Centers were selected from the West Coast. The West Coast was included particularly for its association with the aerospace industry. Four Centers were sampled in the South. It was felt that in this territory, Centers would cover larger geographical areas and serve less heavily industrialized markets. Four Centers were selected in the Mid-Atlantic region in close priximity to many mills and ports where imported steel would be a competitive factor. New England provided three Centers for the sample. Climate, competition and types of users make New England unique. Two Centers were selected in the Southwest in order to cover some Centers which serve an expansive area. Two Centers were selected in the Ohio Valley because of the heavy industry located in this area.

This research was designed in order to examine physical distribution patterns in the Metals Service Center industry and to determine the affect of size and profit on these patterns. Attitudes toward customer service among various job holders within the Centers were compared. In

order to carry out this research, a maximum performance model of physical distribution in this industry was constructed, and data were collected depicting physical distribution patterns as they exist. These data were broken down according to size and profit and compared with the model. This chapter describes the research design; the following chapter covers in detail the maximum performance physical distribution model.[1]

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[1]It is recognized that a total systems model would include all aspects of distribution including a detailed analysis of inventory control, location theory, purchasing and other related functions. Within this total system, trade-offs would occur. The model used in this thesis serves as a check list for thirty-seven major physical distribution factors. The model does not include all possible elements of a total physical distribution system and does not incorporate the trade-off principle. When using this model, centers should measure how well they conform to the maximum performance model, relate the 37 factors to the total system, and the trade-offs into account.

CHAPTER IV

PHYSICAL DISTRIBUTION MODEL

General Use of Models

Models and the Systems Approach

The perspective of the research is that physical distribution is a system. "A system is defined as a complex of interrelated components."[1] All components of a system must work together if the system is to reach maximum effectiveness. Physical distribution, a system, may also be viewed as a sub-system within the firm along with finance, production and marketing. In turn the firm may be considered a sub-system within the channel of distribution. Finally, the channel may be depicted as a sub-system of the steel industry, or, perhaps, of the total economy.

Systems thinking allows for the possibility of increased efficiency by optimizing the operation of the system as opposed to optimizing the individual components. In fact, optimization of system goals may occur through suboptimization of one or more components. Systems

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[1]Robert E. Schellenberger, Managerial Analysis (Homewood, Illinois: Richard D. Irwin, Inc., 1969), p. 90.

thinking also helps management to clarify its objectives. Sub-systems goals or objectives are redefined so that achievement of these goals will lead to the realization of the goals of the total system. Executive decision-making under a systems approach is made less difficult because the executive is looking at many activities and their interrelationships. Solutions to systems problems can be simplified by the use of models built to represent the system. Models and systems have become powerful interpretive tools.[1]

A model is "a physical or symbolic representation of the relevant aspects of the reality with which we are concerned."[2] A model attempts to convey reality, and uses various approaches to convey this reality. Two basic approaches to model building are abstraction and realization. In abstraction, a real world situation is perceived and it is mapped into a model; realization is a situation in which the builder starts with a consideration of a logically consistent conceptual system.[3]

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[1]Paul Meadows, "Models, System and Science," American Sociological Review, Vol. 22 (February, 1957), pp. 3-9.

[2]Schellenberger, op. cit., p. 83.

[3]William Lazer, "The Role of Models in Marketing," Journal of Marketing, Vol. 26, No. 2 (April, 1962), p. 9.

Models have several advantages. They provide a frame of reference for consideration of the problem. Models may suggest information gaps and approaches for action. Models bring forth a greater understanding of the system being modeled. Models allow for simulation of the operation of the system; changes in the system can be simulated and the results observed. Simulation is a less expensive means of experimenting with a system than actually going ahead and changing the system. Models also provide "the most successful predicting systems so far produced."[1]

Various classifications of models have been developed. Classification may be made according to purpose, e.g., descriptive models are designed to describe what is, whereas normative models are designed to show what should be. Alternatively, classification may be made by technique, e.g., mathematical models which use quantitative techniques such as linear programming; verbal models which present the system in prose.[2] Models can also be classified as static or dyanmic. "A model is static if it deals with time periods on an exclusive basis. It is

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[1]Irwin D. J. Bross, "Models" in Scientific Decision Making in Business, ed. by Abe Schuchman (New York: Holt, Rinehart and Winston, Inc., 1963), p. 69.

[2]Ronald C. Frank, Alfred A. Kuehn and William F. Massy, Quantitative Techniques in Marketing (Homewood, Illinois: Richard D. Irwin, Inc., 1962), p. 106.

dynamic if the model attempts to deal with intertime period relationships."[1] The model developed in this thesis is verbal and shows the maximum performance any center can achieve.

Purpose of the Physical Distribution Model

The model developed describes, verbally, the physical distribution system that should be in operation in the Metals Service Center industry. Real world patterns are then compared with the model, the objective being to test the hypothesis that real world congruency with the model is a function of the Center's size and its profitability.

The model has a practical use in that Centers can compare their physical distribution systems with the model system. Such comparisons, hopefully, will lead to improvements in each firm's physical distribution system.

Model of Physical Distribution Patterns

This model begins when the order arrives at the Center. From there the model is broken down into three sections, based on the three major physical distribution work areas in the Center--order processing, warehousing handling and transportation.

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[1]Donald J. Bowersox, Edward W. Smykay and Bernard J. LaLonde, Physical Distribution Management (New York: The Macmillan Company, 1968), p. 328.

Order Processing

Orders should be placed in the Center via telephone. Telephone ordering provides the minimum amount of transmittal time and allows the Center's physical distribution activities to begin as soon as the customer decides to order. In addition, this type of ordering is prevalent in the industry and Centers have experienced inside sales personnel to handle the order, can give the customer personal service and can set up standard processing routines based on one standard method of receiving orders.

Orders should be placed in the Center evenly throughout the day. When there is an even placement of orders daily routines can be arranged and adhered to and orders can be moved to the warehouse rapidly without costly bottlenecks. Maximum utilization of employees can be achieved also.

Mechanical means of inventory control should be used where the size of the Center merits the investment. Computerized inventory management, whether it be on a small scale with paper printouts or on a large scale with the use of video consoles, increases the speed of order processing and is more accurate than a Kardex system. Such systems are more efficient since they free hours of labor used to maintain a Kardex system.

Complete credit checks on each order should be avoided wherever possible. Credit checking systems should

make use of account codes set up by the finance department. The use of codes will allow most orders to move toward the warehouse without an additional interruption.

Mechanical means of order entry should be used if the size of the Center merits the investment. Mechanical means disengages the inside salesman from the order-writing task and allows him to concentrate on selling. Delays are not incurred because orders get tied up on the sales desk. Orders are neater and more accurate, which help to reduce order picking errors. Mechanical means also can result in specialization of labor, as certain individuals enter orders consistently.

Data processing should be used as extensively as possible in the Center. This does not means that all firms would have to own computers, there are plans available where computer time can be leased. Extensive use of data processing would include usage in sales analysis, accounting, invoicing, distribution studies and analysis, inventory control and order entry. Data processing keeps the flow of information moving rapidly through Centers, and it is through this information that physical distribution operates at its maximum efficiency. Data processing helps to provide controls, allows for speed and accuracy in making the physical distribution system work and simplifies total cost analysis.

Orders should move as directly as possible to the warehouse. There should be few delays in the order processing function so that the total physical distribution moves rapidly. Speed in order processing is essential. Orders should move as rapidly through the order processing function as possible. Slowdowns here put added pressure on the warehouse and on the transportation department. Time lost in order processing is just as detrimental to the physical distribution system as time lost in order picking or delivery.

Order processing costs should be as low as possible. Centers should be aware of their costs and their relationship to physical distribution. The proper meaning of cost is low total cost consistent with stated customer service levels. Low order processing costs by themselves could mean increased delivery costs or reduced speed and accuracy in order processing. Low cost here means the lowest total cost consistent with customer delivery standards.

Orders handled on a special basis should be kept to a minimum. Special handling disrupts routines, increases costs, decreases overall physical distribution efficiency and may have a negative effect on other orders.

Decisions as to which orders should be given special handling should be made at a higher level than the inside sales desk. At a higher level, the overall results of not giving special service can be calculated, i.e., will

failure to provide special service mean a lost sale or perhaps a lost account?; will the Center's reputation for providing good service be damaged?

Warehouse Handling

Pre-production processing should have a minimum effect on the scheduling of orders. Orders should move swiftly through the warehouse and should not be delayed inordinantly by pre-production processing. If Centers have proper production control techniques and if pre-production processing machines are properly located so as to facilitate the flow from order picking to shipping, then pre-production processing will have a minimum effect on order scheduling.

Production control techniques should be employed for processed orders. Production control techniques allow for proper control of orders through the warehouse and reduce delays. Controls improve customer service by allowing for accurate estimates on job completions. Production control permits the scheduling of transportation prior to completion, thus providing for the more efficient use of transportation.

Warehouses should be well-designed. Well-laid out warehouses utilize space to the maximum, provide for efficient materials handling, provide maximum service at the lowest cost, reduce loss, and decrease damage and the risk of accidents. In addition, good warehouse design should

provide maximum flexibility to meet storage and handling requirements and make the warehouse a model of good housekeeping.[1]

Warehouses should have well-designed materials handling systems. Proper materials-handling equipment is related to warehouse design and racking systems; all three must work together. A good materials handling system can facilitate movement of goods at low costs, lower incidence of loss and damage, prevent accidents, ease congestion and increase the overall warehouse efficiency.

Warehouses should have well-designed storage systems. Very often, storage equipment is as important as handling equipment to the total cost and success of warehouse operations. Storage systems should be well-designed in order to facilitate movement, reduce order picking and handling time, reduce searching time, put space to better utilization and reduce loss and damage.

Standard times should be set up for shipping orders. Shipping at set times maximizes the utilization of the warehouse work force and provides for the orderly operation of the warehouse. Interruptions in other operations, such as receiving can be reduced, handling equipment can be more efficiently used, special personnel can be

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[1]Creed Jenkins, Modern Warehouse Management (New York: McGraw-Hill Book Company, 1968), p. 69.

employed for loading and orders can be staged for better, more efficient loading.

Special personnel other than drivers should be employed for truck loading. Special personnel will be familiar with handling equipment and know where material is on the dock. Trucks can be more efficiently loaded by special personnel, damage can be minimal, the loading of wrong orders can be reduced and orders can be programmed for delivery. Drivers can be more efficiently used through this arrangement, as all that they might have to do is to tie down the load and depart.

Customer "will'calls" should be discouraged. Will-calls mean that the complete warehouse schedule has to be interrupted in order to load the customer's truck. Loading is inefficient and often time-consuming, because the buyer generally does not have good equipment and people without proper training in loading might be called upon to do the job. Because of the above reasons the possibility of damage or accidents increases.

Shipping delays should be avoided whenever possible. Delays slow down the complete warehouse operation, increase the cost of shipping, can cause orders to miss their scheduled delivery date and often take managerial personnel away from their other duties to concentrate on shipping problems.

Warehouse costs should be minimized. As in order processing, the relevant cost figure here is total cost. In his book, Modern Warehouse Management, Creed Jenkins says,

> In the entire production and distribution cycle, the warehouse is probably the least efficient . . . Corporate management has largely come to recognize that warehousing is one of the few areas of business where major savings are yet to be attained.[1]

Transportation

Orders should be scheduled for transportation prior to pre-production processing. This will be difficult unless the Center has a production control operation. Scheduling prior to processing will provide for better utilization of equipment, maximum utilization of the Center's trucks, better planning of deliveries, and will help prevent last minute shifts of tonnage which disrupt deliveries.

Daily transportation routes should be used to aid in the movement of outbound tonnage. Such schedules provide for better planning of the Center's transportation fleet, better utilization of equipment, consistency in meeting delivery dates, and provide the sales force with more information and allow for coordination between sales and delivery.

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[1]Jenkins, Ibid., p. 95.

Private transportation should be the major form of transportation used by Centers for outbound orders. Private transportation will allow for consistent service, provide the best means of meeting delivery commitments, and allow for better utilization of equipment. In addition, better loading schedules can be arranged and both the trucks and drivers can be used as a form of promotion.

Private transportation should be used to effect better delivery service or assure better control over operations. Each Center's delivery service commitments would be hard to achieve, if not impossible, with common carriers. In a very competitive industry like this one, private transportation can help improve the Center's competitive position. Control can be exercised over loading times, type of equipment, delivery times and the type of drivers used.

Where Centers use private transportation, equipment should be leased instead of purchased. Leasing frees the Center of the problem of getting rid of old vehicles and provides for regular replacement. Extra vehicles can be supplied when the regular ones are being repaired and the Center has no need to get into the area of fleet maintenance. In addition, leasing means that capital which would be invested in a truck fleet might be invested in another phase of the business or outside the business.

Trucks should be loaded as heavily as possible. Each truck which leaves the Center should have as much of its weight potential used as possible. This provides for the maximum utilization of each vehicle. This is, of course, subject to various state regulations regarding weights allowed per axle.

Trucks should make as few stops as possible. Each time a truck makes a stop, it must wait to be received, and then wait while the truck is unloaded; then, the truck must be routed to the next delivery point. The more stops per trip, the harder it is to set up effective routing. Loss and damage is increased when large numbers of orders are mixed together on the same truck.

The weight delivered per stop should be as high as possible. This item is a combination of the previous two. It may be hard to load the trucks as heavily as possible without increasing the number of stops. The opposite may also be true, the number of stops can be reduced by cutting down the weight. What is desired is heavy weights per stop.

Drivers should make only one trip per day. When drivers make one trip per day, deliveries can be better planned. There will be fewer interruptions than if the driver has to be reloaded or given a job in the warehouse. It will be less costly if the driver gets one load and delivers it rather than returning several times for reloading.

Drivers should not make the same run every day. By making different runs every day, drivers become familiar with all of the Center's customers, and they do not get stale, or become overly friendly with customers. Drivers can fill in for each other without any loss of efficiency. Centers have greater flexibility in planning delivery, can compare one driver's performance on a run with anothers, and might be able to learn more about a customer by having several drivers' opinions.

Drivers should do no unloading nor should they put material away for customers. These activities add time and expense to the Center's delivery. Often an additional man is required to perform such activities. The customer has the facilities for performing these functions and should do so.

Centers should have methods set up to determine the customer's unloading facilities. These methods provide for proper bundling and packaging. Orders can be delivered faster when the Center's trucks arrive at the right time and are unloaded quickly. Damage to material or injury to those unloading can be reduced. Coordinating delivery with the customer's unloading facilities can also be used as a positive marketing tool.

Procedures should be employed to check and control drivers. This can result in economics in delivery and provide for better management of delivery. Better

utilization of the company's fleet can occur and drivers will be more conscientious in their delivery activities. Controls also tell management when a change in delivery patterns is required.

Delivery should be made on a routine basis whenever possible. Routine handling allows for a minimum of disruption in delivery, maximizes the utilization of equipment and helps maintain low distribution costs. Special handling has a chain reaction, and bottlenecks occur in other areas throughout the physical distribution system.

First morning delivery is desirable on non-processed orders. Competition in this industry has made first morning delivery on non-processed orders a necessity. When a customer calls in for a non-processed order, he knows that the Center's competitor can make the delivery commitment, if that Center cannot. Fast delivery on processed orders is desirable. This is related to the previous point. In most markets, the delivery standard for various types of processed orders is known. In Seattle, for example, orders requiring slitting may take four days to process. Four days becomes standard, and customers begin to look upon four days as the delivery date Centers must meet.

Transportation costs should be minimized. It is incumbent upon the Centers to reduce the total cost of transportation. As previously stated, this must be done

in full cognizance of the systems approach and with the awareness of the fact that such cost must be reduced in relation to a stated customer delivery standard.

Centers should engage in back-hauling material to as great an extent as possible. Costs incurred in returning to the Center empty are joint in that the costs incurred in delivering the material automatically create the costs to return to the Center. Since the trucks must return to the Center empty, any type of freight which can be brought back, e.g., buy-outs or purchases from the mill, will help reduce the cost of delivery.

The preceding part of this chapter has outlined a maximum performance physical distribution model. This model is used as a point of reference to compare what occurs in the real world with what should be occurring. In order to do this, a system of measuring the real world must be devised.[1]

Measurement

A four point scale is designed to measure how close the sample Centers come to the model depicted above. If the Center has complete congruence with the model, then three points are awarded. If the Center's activities are the antithesis of the model, then no points are awarded. (See Figure 2.) If a Center were to match the model on every point in the three areas--order processing, warehouse handling and transportation--then that Center would

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[1]See footnote one, p. 56.

PART A. ORDER PROCESSING

	Physical Distribution Factor	Basis For Maximum Points
1.	Arrival of the order at the Center	Maximum amount arrive by telephone
2.	Time when orders arrive	Orders arrive evenly throughout the day
3.	Inventory control	Mechanical methods used
4.	Credit check	Codes are set up for customers
5.	Order entry	Mechanical methods used
6.	Data processing	Extensive use of data processing
7.	Speed in order processing	Rapid movement of the order to the warehouse
8.	Cost	Low costs consistent with good customer service
9.	Special handling of orders	Minimum number of orders handled on a special basis
10.	Decision as to whether an order gets special handling	Decision is made by top management

PART B. WAREHOUSE HANDLING

11.	Scheduling of orders which are pre-production processed	Pre-production processing should have a minimum effect on scheduling
12.	Production control	Production control departments should be employed
13.	Warehouse design	Warehouse design should be excellent
14.	Materials handling system	Materials handling system should be excellent
15.	Racking system	Racking system should be excellent
16.	Shipping times	Standard times should be used for shipping
17.	Truck-loading	Drivers should not load trucks
18.	Will-calls	There should be as few will-calls as possible
19.	Shipping delays	Shipping delays should be kept to a minimum
20.	Cost	Low costs consistent with good customer service

PART C. TRANSPORTATION

21.	Scheduling of transportation	Scheduling done prior to selection
22.	Transportation routes	Daily routes utilized
23.	Outbound tonnage	Private transportation used to the greatest extent possible
24.	Reason for using private transportation	Effect better delivery service
25.	Method of acquiring fleet	Trucks leased with good reasons for doing so
26.	Truck tonnage	Loaded as heavily as possible
27.	Number of stops per trip	As few stops as possible
28.	Weight per stop	Maximum weight per stop
29.	Number of trips per day by a driver	One trip per day
30.	Nature of the driver's trip	Drivers should not make the same run every day
31.	Extent of unloading by driver	No unloading by driver
32.	Determination of customer's facilities	Mail questionnaires used
33.	Driver controls	Procedures set up to check on drivers
34.	Special delivery of orders	Minimum amount of special delivery
35.	Delivery time	High percentage delivered on the first morning
36.	Costs	Low costs consistent with good customer service
37.	Back-haul	Mill purchases and "buy-outs" carried on back-haul

Figure 2.--Basis for assignment of maximum points for physical distribution model.

have a total of 111 points. Appendix B details the method of distributing points for each item covered in the model.

The following chapter contains an analysis of the Centers according to size and profit. Comparisons are made between the Centers' physical distribution activities and the model described in this chapter.

CHAPTER V

EXPERIMENTAL RESULTS

Introduction

Chapter V contains the findings resultant from the research undertaken. In the first section, the sample Centers are compared with the maximum performance model. The number of points scored by the sample Centers for each of the 37 physical distribution factors is compared with the maximum performance model. In addition to the comparison of all 37 factors, the physical distribution factors are studied in three separate groupings. The first is order processing, which covers the order from the time it is received in the Center until it is sent to the warehouse. Grouping two, warehouse handling, begins when the order is received in the warehouse and ends with the loading of the trucks. Transportation makes up the final grouping.

In section one, the mean scores of the sample Centers are compared with the maximum scores of the normative model. A one-tail test was used to test significance. Significane tests were conducted for all factors combined and then for each of the three groupings. Tests are run to see if the observed mean score of the sample

is significantly less than the maximum score of the maximum performance model.

In section two, size of Centers is investigated relative to physical distribution effectiveness. Size is measured in terms of the number of orders handled per day. Centers handling 125 orders or less per day are classified as small. Those handling 126 orders or more a day are classified as large. Of the 24 Centers included in the sample, eleven are in the small category and thirteen in the large group. The data are analyzed for all 37 factors and then for three separate groupings, order processing, warehouse handling and transportation.

The test used in section two is a two-tail test for the significance of the difference between the mean number of points scored per physical distribution factor for small Centers and the mean number of points scored per physical distribution factor by large Centers. The null hypothesis is that the two samples are drawn from the same population. Tests for the significance of differences between two means were used for the total of all physical distribution factors and for each of the three groupings.

In section three of this chapter the control variable is profit. Analysis was made as in section two. The measure used for profitability in this study was: "net profit before taxes as a per cent of net sales." It

was felt that this figure was one which would provide a fair measure of comparison among Centers. It was also felt that a reliable figure could be obtained here and one that would be readily available.

Profitability was grouped into two classifications, high and low. Those Centers which claimed a net profit of four per cent or more were considered in the high profit classification. Centers in which profit was less than four per cent were classified as low profit Centers, this class including several Centers which lost money. Four per cent was selected as the difference between low and high profit because this figure split the Centers into even groups of twelve and because four per cent is near the industry average.

The remainder of this chapter contains the research results.

Comparison of Sample Centers and the Model

Order Processing

The model contains ten factors dealing with order processing, and each factor has been allocated a maximum of three points. Thus the maximum score a Center can obtain is 30. The average score on order processing was 15.37, far short of the 30 maximum. This

difference is significant at the five per cent level of confidence.[1]

Note that Table 1 contains not only the mean score on order processing, but also mean scores obtained on each factor. Inspection reveals that Centers do their best job on order receipt where they limit the number of orders received via non-standard methods, limiting the number of orders handled on a special basis and in the speed with which orders are processed. Centers do least well on order processing cost, method of order entry and their methods of controlling inventory.

Warehouse Handling

There are ten physical distribution factors in warehouse handling with each factor allocated a maximum of three points. Thus, as in the case of order processing, the maximum score obtainable is 30. The average score on warehouse handling was found to be 16.63, which is short of the 30 point maximum. This difference is significant at the five per cent level.

Table 1 contains not only the mean score on warehouse handling, but also mean scores obtained on each factor. Inspection reveals that Centers do their best job on the use of standard shipping times, on the limitation placed on drivers unloading and in the reduction of

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[1]Appendix C contains the statistical data used in this chapter.

TABLE 1.--Distribution of points allocated to the sample Centers.

	Physical Distribution Factor	Total Points All Centers		Mean Scores
1.	Arrival of the order at the Center	55		2.29
2.	Receipt of the order throughout the day	41		1.71
3.	Method of controlling inventory	26		1.08
4.	Extent of credit check	40		1.67
5.	Method of order entry	22		.92
6.	Extent of the use of data processing	29		1.21
7.	Speed in order processing	45		1.88
8.	Order processing cost	20		.83
9.	Number of orders handled on a special basis	49		2.04
10.	Where the decision on special handling is made	42		1.75
	Total Points Order Processing		369	
	Average Score Order Processing			15.37
	Average Number of Points Per Factor			1.54
11.	Affect of pre-production processing on scheduling	42		1.75
12.	Degree of production control	33		1.38
13.	Warehouse design	25		1.04
14.	Materials handling system	32		1.33
15.	Packing material	36		1.50
16.	Use of standard shipping times	65		2.71
17.	Degree of loading by drivers	58		2.42
18.	Degree will calls	50		2.08
19.	Causes in shipping delays	34		1.42
20.	Warehouse costs	24		1.00
	Total Points Warehouse Handling		399	
	Average Score Warehouse Handling			16.63
	Average Number of Points Per Factor			1.66
21.	Scheduling orders prior to selection	40		1.67
22.	Use of daily transportation routes	43		1.79
23.	Outbound tonnage	58		2.42
24.	Reason for using private transportation	48		2.00
25.	Method of acquiring their private fleet	49		2.04
26.	Weight per loaded truck	31		1.29
27.	Stops per trip	29		1.21
28.	Weight per stop	25		1.04
29.	No. of trips per day per driver	37		1.54
30.	Nature of driver's daily trip	37		1.54
31.	Amount of unloading by driver	31		1.29
32.	Determination of customer's facilities	25		1.04
33.	Extent of control over drivers	39		1.63
34.	Per cent of orders requiring special delivery	43		1.79
35.	Ability to deliver orders on first morning	40		1.67
36.	Extent of back-haul activity	34		1.42
37.	Transportation costs	34		1.42
	Total Points Transportation		643	
	Total All Sample Centers		1411	
	Average Score Transportation			26.78
	Average Number of Points Per Factor			1.58
	Average Score All Centers			58.79
	Average Number of Points Per Physical Distribution Factor			1.59

will calls. They do least well on warehouse costs, warehouse design and in the design of materials handling systems.

Transportation

There are seventeen physical distribution factors in transportation, with each factor allocated a maximum of three points. Thus, the maximum score obtainable by any Center is 51. The average score on transportation was 26.79, which was considerably below the 51 point maximum. The difference is significant at the five per cent level of significance.

Table 1 contains not only the mean score on transportation, but also mean scores obtained on each transportation factor. Inspection reveals that Centers do their best job on the use of private transportation for outbound tonnage, the method of acquiring their private fleet, the justification for using private transportation, the use of daily transportation routes and on the reduction of orders requiring special delivery. They do least well on building up the maximum weight per stop, adequately determining the customer's delivery facilities, limiting the number of stops per trip, maximizing the weight per loaded truck and on controlling the amount of unloading done by the driver.

Total Physical Distribution System

There are a total of 37 physical distribution factors with each factor allocated a maximum of three points. Thus, the maximum score a Center can obtain is 111. The average score for the sample was 58.79 points, which was quite short of the 111 point maximum. This difference is significant at the five per cent level of confidence.

Note that Table 1 contains not only the mean score for the sample, but also the average number of points scored per physical distribution factor for each of the three physical distribution subsets--order processing, warehouse handling and transportation. Centers did their best on warehouse handling where they average 1.66 points per factor. They did least well on order processing where they average only 1.54 points per physical distribution factor. Transportation was in between warehouse handling and order processing, as Centers averaged 1.58 points per physical distribution factor.

Experimental Results Based on Size

Order Processing

Order processing contains ten physical distribution factors with each factor allocated a maximum of three points. Thus, as explained in section one, the maximum score obtainable by any Center is 30. The average score

for small Centers was 14.73, while the average score for large Centers was a little higher at 15.92. A test for the significance of the difference between these two means was used. This difference is not significant at the five per cent level.

Table 2 contains not only the mean score on order processing for large and small Centers, but also mean scores obtained on each factor. Small Centers do best on standardizing the arrival of the order at the Center, processing orders quickly and in reducing the number of orders handled on a special basis. Small Centers do least well on order processing cost, methods of order entry and methods of controlling inventory. Large Centers do not differ from small Centers in what they do well and what they do poorly.

Warehouse Handling

Warehouse handling contains ten physical distribution factors with each factor allocated a maximum of three points. Thus, as explained in section one, the maximum score obtainable by any Center is 30. The average score for small Centers was 15.64, while the average score for large Centers was a little higher at 17.46. A test for the significance of the difference between these two means was used. This difference is not significant at the five per cent level.

TABLE 2.--Distribution of points allocated to Centers based on size.

	Physical Distribution Factor	Small		Large	
		Total Points All Centers	Mean Score	Total Points All Centers	Mean Score
1.	Arrival of the order at the Center	23	2.09	32	2.46
2.	Receipt of the order throughout the day	21	1.91	20	1.54
3.	Method of controlling inventory	10	.91	16	1.23
4.	Extent of credit check	18	1.64	22	1.69
5.	Method of order entry	8	.73	14	1.08
6.	Extent of the use of data processing	11	1.00	18	1.39
7.	Speed in order processing	22	2.00	23	1.77
8.	Order processing cost	8	.73	12	.92
9.	Number of orders handled on a special basis	22	2.00	27	2.08
10.	Where the decision on special handling is made	19	1.73	23	1.77
		162		207	
	Average Score		14.73		15.92
	Average Number of Points Per Physical Distribution Factor		1.47		1.59
11.	Affect of pre-production processing on scheduling	19	1.73	23	1.77
12.	Degree of production control	15	1.36	18	1.39
13.	Warehouse design	12	1.09	13	1.00
14.	Materials handling system	13	1.18	19	1.46
15.	Packing material	14	1.27	22	1.69
16.	Use of standard shipping times	27	2.45	38	2.92
17.	Degree of loading by drivers	22	2.00	36	2.77
18.	Degree will calls	18	1.64	32	2.46
19.	Causes in shipping delays	17	1.55	17	1.31
20.	Warehouse costs	15	1.36	9	.69
		172		227	
	Average Score		15.64		17.46
	Average Number of Points Per Physical Distribution Factor		1.56		1.75
21.	Scheduling orders prior to selection	17	1.55	23	1.77
22.	Use of daily transportation routes	13	1.18	30	2.31
23.	Outbound tonnage	27	2.45	31	2.39
24.	Reason for using private transportation	19	1.55	31	2.39
25.	Method of acquiring their private fleet	13	1.73	30	2.31
26.	Weight per loaded truck	16	1.18	18	1.39
27.	Steps per trip	10	1.45	13	1.00
28.	Weight per stop	11	.91	15	1.36
29.	No. of trips per day per driver	20	1.00	26	2.00
30.	Nature of driver's daily trip	17	1.82	17	1.31
31.	Amount of unloading by driver	11	1.55	14	1.08
32.	Determination of customer's facilities	11	1.00	14	1.08
33.	Extent of control over drivers	17	1.55	22	1.69
34.	Per cent of orders requiring special delivery	18	1.64	25	1.92
35.	Ability to deliver orders on first morning	15	1.36	25	1.92
36.	Extent of back-haul activity	12	1.09	22	1.69
37.	Transportation costs	18	1.64	16	1.23
		271		372	
	Average Score		24.64		28.62
	Average Number of Points Per Physical Distribution Factor		1.45		1.68
	Average Score All Centers		55		62
	Average Number of Points Per Physical Distribution Factor		1.49		1.68
		605		806	

Table 2 contains not only the mean score on warehouse handling for large and small Centers, but also mean scores obtained on each factor. Small Centers do best on the use of standard shipping times, limiting the amount of loading done by drivers and on controlling the effect of pre-production processing on scheduling. Large Centers do not differ on the first two factors above, but their third best factor is the control of will-calls. Both large and small Centers do least well in warehouse design. Small Centers do poorly on materials handling systems and racking systems, whereas large Centers do poorly on warehouse costs and on the causes of shipping delays.

Transportation

Transportation contains seventeen physical distribution factors with each factor allocated a maximum of three points. Thus, as explained in section one, the maximum score obtainable by any Center is 51. The average score for small Centers was 24.64, while the average score for large Centers was a little higher at 28.62. A test for the significance of the difference between these two means was used. This difference is not significant at the five per cent level.

Table 2 contains not only the mean score on transportation for large and small Centers, but also mean scores obtained on each factor. Small Centers do their

best job on the use of private transportation for outbound tonnage, sending their drivers on different routes and in their method of acquiring their private fleet. Large Centers do best on the same factors except they do better on good reasons for using private transportation instead of sending their drivers on different routes. Small Centers do poorly in weight per stop, determination of customer's facilities and on back-haul activity. Large Centers do poorly on stops per trip, the amount of unloading done by drivers and on determining customer's facilities.

Total Physical Distribution System

The normative model contains 37 physical distribution factors with each factor allocated a maximum of three points. Thus, as explained in section one, the maximum score obtainable by any Center is 111. The average score for small Centers was 55, while the average score for large Centers was a little higher at 62. A test for the significance of the difference between these two means was used. This difference is not significant at the five per cent level.

Note that Table 2 shows there was a minor difference between large and small Centers in terms of their performance on the three groups. Small and large Centers did their best job on warehouse handling. Small Centers

did their next best job on order processing and they did the poorest on transportation. Large Centers did second best on transportation and poorest on order processing.

Experimental Results Based on Profit

Order Processing

Order processing contains ten physical distribution factors with each factor allocated a maximum of three points. Thus, as explained in section one, the maximum score obtainable by any Center is 30. The average score for low profit Centers was 16.33, while the average score for high profit Centers was a little lower at 14.42. A test for the significance of the difference between these two means was used. This difference is not significant at the five per cent level.

Table 3 contains not only the mean score on order processing for high profit and low profit Centers, but also mean scores obtained on each factor. Low profit Centers do their best job on standardizing the arrival of the order at the Center, fast order processing and on placing the decision for special handling at a high level. They do least well on method of order entry, order processing cost and method of controlling inventory. High profit Centers do best on controlling the number of orders handled on a special basis, scheduling the arrival

TABLE 3.--Distribution of points allocated to Centers based on profit.

Physical Distribution Factor	Low Profit		High Profit	
	Total Points All Centers	Mean Score	Total Points All Centers	Mean Score
1. Arrival of the order at the Center	29	2.42	26	2.17
2. Receipt of the order throughout the day	20	1.67	21	1.75
3. Method of controlling inventory	16	1.33	10	.83
4. Extent of credit check	17	1.42	23	1.92
5. Method of order entry	11	.83	11	.92
6. Extent of the use of data processing	16	1.33	13	1.08
7. Speed in order processing	27	2.25	18	1.50
8. Order processing cost	14	1.17	6	.50
9. Number of orders handled on a special basis	22	1.83	27	2.25
10. Where the decision on special handling is made	24	2.00	18	1.50
	196		173	
Average Score		16.33		14.42
Average Number of Points Per Physical Distribution Factor		1.63		1.44
11. Affect of pre-production processing on scheduling	21	1.75	21	1.75
12. Degree of production control	17	1.42	16	1.33
13. Warehouse design	12	1.00	13	1.08
14. Materials handling system	17	1.42	15	1.25
15. Packing material	18	1.50	19	1.58
16. Use of standard shipping times	31	2.58	34	2.83
17. Degree of loading by drivers	28	2.33	30	2.50
18. Degree will calls	23	1.92	27	2.25
19. Causes in shipping delays	16	1.33	18	1.50
20. Warehouse costs	15	1.25	9	.75
	198		201	
Average Score		16.50		16.75
Average Number of Points Per Physical Distribution Factor		1.65		1.68
21. Scheduling orders prior to selection	22	1.83	18	1.50
22. Use of daily transportation routes	24	2.00	19	1.58
23. Outbound tonnage	27	2.58	27	2.25
24. Reason for using private transportation	24	2.00	24	2.00
25. Method of acquiring their private fleet	26	2.17	23	1.92
26. Weight per loaded truck	15	1.25	16	1.33
27. Stops per trip	19	1.58	10	.83
28. Weight per stop	12	1.00	13	1.08
29. No. of trips per day per driver	19	1.58	18	1.50
30. Nature of driver's daily trip	19	1.58	18	1.50
31. Amount of unloading by driver	14	1.17	17	1.42
32. Determination of customer's facilities	14	1.17	11	.92
33. Extent of control over drivers	17	1.42	22	1.83
34. Per cent of orders requiring special delivery	21	1.75	22	1.83
35. Ability to deliver orders on first morning	23	1.92	17	1.42
36. Extent of back-haul activity	17	1.42	17	1.42
37. Transportation costs	18	1.50	16	1.33
	335		308	
Average Score		27.92		25.67
Average Number of Points Per Physical Distribution Factor		1.64		1.51
Average Score All Centers		60.75		56.83
Average Number of Points Per Physical Distribution Factor		1.64		1.54
	729		682	

of orders and reducing the extent of credit checks. They do least well on order processing cost, methods of inventory control and method of order entry.

Warehouse Handling

Warehouse handling contains ten physical distribution factors with each factor allocated a maximum of three points. Thus, as explained in section one, the maximum score obtainable by any Center is 30. The average score for low profit Centers was 16.50, while the average score for high profit Centers was a little higher at 16.75. A test for the significance of the difference between these two means was used. This difference is not significant at the five per cent level.

Table 3 contains not only the mean score on warehouse handling for high profit and low profit Centers, but also mean scores obtained on each factor. Low profit Centers and high profit Centers do best on the use of standard shipping times, limited loading by drivers and controlling will-calls. Both do their lowest scoring on warehouse costs and warehouse design.

Transportation

Transportation contains seventeen physical distribution factors with each factor allocated a maximum of three points. Thus, as explained in section one, the maximum score obtainable by any Center is 51. The average

score for low profit Centers was 27.92, while the average score for high profit Centers was a little lower at 25.67. A test for the significance of the difference between these two means was used. This difference is not significant at the five per cent level.

Table 3 contains not only the mean score on transportation for low and high profit Centers, but also mean scores obtained on each factor. Low and high profit Centers do their best job on using private transportation for outbound tonnage, their reasons for using private transportation and on their method of acquiring their private fleet. Low profit Centers do their lowest scoring on weight per stop, controlling the drivers' unloading and determining customer facilities. High profit Centers do worst on stops per trip, determining customer's facilities and weight per stop.

Total Physical Distribution System

The normative model contains 37 physical distribution factors with each factor allocated a maximum of three points. Thus, as explained in section one, the maximum score obtainable by any Center is 111. The average score for low profit Centers was 60.75, while the average score for high profit Centers was a little lower lower at 56.83. A test for the significance of the

difference between these two means was used. This difference is not significant at the five per cent level.

Table 3 shows that there was no difference between low profit and high profit Centers in terms of their performance on the three physical distribution groupings. Both did their best job on warehouse handling and their poorest on order processing. Note that Table 3 shows that the differences between groups was greater for high profit Centers.

This chapter has presented the results of the research undertaken in this thesis with respect to comparing the physical distribution systems of sample Centers with the maximum performance model. The following chapter presents the research findings which compare the attitudes on customer service among job holders in the Center. The final chapter presents the conclusions and recommendations.

CHAPTER VI

COMPARATIVE ANALYSIS--ATTITUDES ON CUSTOMER SERVICE AMONG JOB HOLDERS IN THE CENTER

Physical Distrubution and the Systems Approach

In Chapter II it was stated that the objective of physical distribution is the achievement of a desired level of customer service at the lowest total cost. The desired level of customer service is attained when the correct order is delivered to the right place at the right time. In the Service Center industry, customer service standards are high. Non-processed orders are required on a next day basis as a rule, and processed orders are required the next day after a back-log period. This back-log period is based on the type of processing being done and on the demand for that type of processing in that area at that time.

The original intent of Chapter VI was to study the attitudes toward customer service of various categories of customers and to compare these findings with attitudes toward customer service of various job categories within the Center. It developed that a study of the customer views was not feasible because of the time and expense

involved and the complex nature of the problem. Hence this phase centers on the comparison of attitudes and perceptions between those in various job categories within the Center. It is hypothesized that if the Center is to be a cohesive unit and work as a system, then incumbents in various assignments should share similar attitudes toward customer service.

Research Findings

Nine questions were asked of those in four job classifications within the Center--inside sales, outside sales, warehouse manager and top management. In each instance a null hypothesis was set that any variation in responses among employees was attributable to sampling error.

Importance of Service

Respondents were asked to express their attitudes regarding the importance of customer service. Seventy-nine per cent of the 91 respondents felt that customer service was "very important." Twenty per cent were of the opinion that service was "important." One respondent felt that service was "very unimportant" (see Table 4).

The chi-square test showed that variations among responses in the four job classes were not significant.

Question number two dealt with whether one Center could handle an order better than another, given

TABLE 4.--The degree to which Centers feel service is important to their customer.

Response	Job Classification									
	I		S		W		M			
	O	E	O	E	O	E	O	E	Total	Per Cent
Very Important	21	(19)	19	(17)	19	(17)	13	(18)	72	79.12
Important	3	(5)	3	(5)	3	(5)	9	(5)	18	19.78
Very Unimportant	0	(0)	0	(0)	0	(0)	1	(0)	1	1.10
TOTAL	24		22		22		23		91	100.00

$$\chi^2 + \frac{(O-E)^2}{E} = 6.67 \quad < \chi^2 \; .05 \; 12.59^{**}$$

$\therefore$ No difference in the feeling toward customer service.

*In this chapter I is for inside sales, S is for outside sales, W is for warehouse manager and M is for top management. O stands for observed frequency and E means expected frequency.

**Computation for the chi-squares in this chapter are detailed in Appendix C.

physically identical products. The overall response was very positive in favor of the ability of a Center to handle orders differently (see Table 5).

Ninety-six per cent of the respondents felt that given identical physical products, one Service Center could still handle an order better than another. Four per cent felt that service would be the same for physically similar products. Here as in question one the χ^2 was not significant.

A third approach in determining the importance of customer service to job groups within the Center was to ask each respondent the extent to which his Center stressed customer service. First each participant was asked whether he felt that his Center overstressed customer service, then he was asked if it were understressed.

Ninety-eight per cent of all respondents believed that customer service is not overstressed in their Center. The response was 100 per cent with the inside and outside sales groups (see Table 6). The computed chi-square was not significant.

There was strong response that customer service was not understressed, although the response was not as emphatic as the response to the question about overstressing. Eighty-one per cent of those participating answered that customer service was not understressed. Nineteen per cent felt that customer service was understressed (see Table 7).

TABLE 5.--Significance of service when physical products are identical.

Response	Job Classification									
	I		S		W		M			
	O	E	O	E	O	E	O	E	Total	Per Cent
Yes	24	(23)	20	(22)	20	(22)	22	(22)	86	95
No	3	(1)	2	(1)	2	(1)	1	(1)	5	5
TOTAL	27		22		22		23		91	100

χ^2 3.16 < χ^2 .05 7.82

∴ No difference between groups with regard to the significance of service.

TABLE 6.--Attitudes on whether Centers overstress customer service.

Response	Job Classification									
	I		S		W		M			
	O	E	O	E	O	E	O	E	Total	Per Cent
Yes	0	(0)	0	(0)	1	(0)	1	(0)	2	2
No	24	(24)	22	(22)	21	(22)	22	(23)	89	98
TOTAL	24		22		22		23		91	100

χ^2 .09 < χ^2 .05 7.82

∴ No significant difference between groups on attitude toward stress placed on customer service.

TABLE 7.--Attitudes on whether Centers understress customer service.

Response	Job Classification									
	I		S		W		M			Per
	O	E	O	E	O	E	O	E	Total	Cent
Yes	7	(5)	5	(4)	5	(4)	0	(4)	17	19
No	17	(19)	17	(18)	17	(18)	23	(19)	74	81
TOTAL	24		22		22		23		91	100

χ^2 6.41 < χ^2 .05 7.82

∴ No significant difference between groups on attitude toward stress placed on customer service

Here, too, no significant difference was found among categories of respondents.

Ability to Perform Service

The second group of questions aimed at the attitudes of participants regarding the ability of their Center to perform service. Even if there is the proper amount of stress placed on customer service, do the Centers respond in such a manner as to get an advantage over their competitors?

The first question asked respondents to compare the ability of their Center to give service with the service capabilities of their top competitors. One per cent felt that their Center was well below their top competitors and one per cent felt they were below. Thirty per cent were of the opinion that they were about the same. Forty-one per cent felt their Center was above top competitors and twenty-seven per cent felt they were well above (see Table 8).

A chi-square test was applied to determine if there were a difference between job classifications in their opinion of the service capability of their Center in comparison with top competitors. The calculated chi-square was 33.19 which is larger than the critical chi-square of 21.03. Hence it can be inferred that differences in response are significant.

TABLE 8.--Self-rating of Centers comparing their ability to give customer service with the ability of the Centers top competitors.

Response	Job Classification									
	I		S		W		M			
	O	E	O	E	O	E	O	E	Total	Per Cent
Well Below	0	(0)	0	(0)	1	(0)	0	(0)	1	1
Below	0	(0)	1	(0)	0	(0)	0	(0)	1	1
Same	13	(7)	5	(7)	4	(7)	5	(7)	27	30
Above	6	(10)	10	(9)	10	(9)	11	(9)	37	41
Well Above	5	(6)	6	(6)	7	(6)	7	(6)	25	27
TOTAL	24		22		22		23		91	100

χ^2 33.19 > χ^2 .05 21.93

H_o is rejected.

There is a significant difference in sentiment regarding the service capabilities of the participants' Center compared with their top competitor.

The second question asked for reasons why Centers do not have the ability to give service. Respondents were asked what they felt were the greatest causes of delay in delivering an order to a customer when he wants it. Forty-one per cent felt that delays occurred in the order processing area. Twenty-three per cent felt that delays come about in the scheduling function, and eleven per cent thought that most delays occur in selecting. Fourteen per cent felt that delays occurred in packing and shipping, and eleven per cent attributed delays to transportation and other factors (see Table 9).

The computed chi-square showed that the differences are not significant.

Major Aspects of Good Delivery Service

Each respondent was asked what he felt was the most important aspect of quick delivery service. Forty-five per cent of the 91 respondents felt that order processing was most important. Another 32 per cent felt that scheduling was the most vital aspect of quick delivery service. Eight per cent thought the most important aspect was selecting and 15 per cent mixed among packing, shipping, transportation, poor inventory control and a combination of all factors (see Table 10).

Here, too, a chi-square test was used to determine if there were a significant difference of opinion between

TABLE 9.--Major causes for failing to meet the customer's desired service level.

Response	Job Classification									
	I		S		W		M			
	O	E	O	E	O	E	O	E	Total	Per Cent
Order Processing	8	(10)	10	(9)	8	(9)	11	(9)	37	41
Scheduling	10	(6)	2	(5)	4	(5)	5	(5)	21	23
Selecting	2	(3)	4	(3)	3	(3)	1	(3)	10	11
Packing and Shipping	2	(3)	5	(3)	3	(3)	3	(3)	13	14
Transportation and Other	2	(3)	1	(3)	4	(3)	3	(3)	10	11
TOTAL	24		22		22		23		91	100

χ^2 11.40 < χ^2 21.03

$\therefore$ Fail to reject Hypothesis

TABLE 10.--The most important aspect of quick delivery service as determined by respondents.

Response	Job Classification									
	I		S		W		M			
	O	E	O	E	O	E	O	E	Total	Per Cent
Order Processing	10	(11)	10	(10)	7	(10)	13	(11)	40	45
Scheduling	8	(8)	7	(7)	11	(7)	3	(8)	29	32
Selecting	3	(2)	3	(2)	1	(2)	1	(2)	8	8
Others	3	(4)	2	(3)	3	(3)	6	(3)	14	15
TOTAL	24		22		22		23		91	100

χ^2 12.35 < χ^2 16.92

$\therefore$ Fail to reject

job classifications regarding the most important aspect of quick delivery service. The null hypothesis holds; the differences are not significant.

Competitive Advantages and Disadvantages

A final set of questions was designed to determine the perceived advantage each respondent felt his Center had over its competition and where it was felt that Centers were at a disadvantage. In the first question, each respondent was asked what he felt was the major competitive advantage his company held over its competitors. Twenty-nine per cent of the respondents claimed their Center's advantage was better delivery service. Nineteen per cent felt the major advantage was a strong product line, and fifteen per cent were of the opinion that the major advantage was variety in the product line. Fourteen per cent felt sales was their major advantage; ten per cent favored product quality and thirteen per cent was distributed among price, reliability, good pre-production processing facilities, well-trained employees and no competitive advantage (see Table 11).

A chi-square test was used to see if there were a significant difference between job classifications regarding the Center's major competitive advantage. The computed chi-square was 30.29 which is larger than the significant chi-square of 24.00. The hypothesis that

TABLE 11.--Perceived competitive advantage held over competitors.

Response	Job Classification									
	I		S		W		M			
	O	E	O	E	O	E	O	E	Total	Per Cent
Sales	3	(3)	3	(3)	3	(3)	4	(3)	13	14
Product Quality	2	(2)	3	(2)	4	(2)	0	(2)	9	10
Efficient Delivery Service	4	(7)	2	(6)	10	(6)	10	(7)	26	29
Strong Product Line	1	(5)	7	(4)	3	(4)	6	(4)	17	19
Variety in Product Line	7	(4)	4	(3)	2	(3)	1	(4)	14	15
Others	7	(4)	3	(3)	0	(3)	2	(3)	12	13
TOTAL	24		22		22		23		91	100

χ^2 30.29 > χ^2 .05 24.00

$\therefore$ Reject Hypothesis

there is no difference between classifications is rejected, and the differences are inferred to be significant.

The question of competitive advantage was reversed, and each respondent was asked what major competitive advantage top competitors held over his Center. Thirty-five per cent of the respondents felt that price was their competitor's top advantage. Twenty-five per cent felt that variety in product line was their competitor's major advantage, and eighteen per cent felt that their competitor's top advantage was a strong product line. Twelve per cent were of the opinion that either sales or better delivery service was their competitor's top advantage. The remaining ten per cent was spread among product quality, better processing equipment and no advantages (see Table 12).

The chi-square test showed that differences are significant.

The final question regarding customer service asked respondents what they felt was the most frequently lodged complaint against their Center. Forty-nine per cent of the respondents thought that price was the most frequently lodged complaint. Thirty-five per cent felt that inefficient delivery service was the most frequent complaint. The remaining fifteen per cent was made up of product quality, small product line and others (see Table 13).

TABLE 12.--Perceived competitive advantage which competitors have.

Response	Job Classification									
	I		S		W		M			
	O	E	O	E	O	E	O	E	Total	Per Cent
Price	8	(8)	11	(8)	9	(8)	4	(8)	32	35
Strong Product Line	5	(4)	5	(4)	3	(4)	3	(4)	16	18
Variety in Product Line	4	(6)	1	(6)	6	(6)	12	(6)	23	25
Service--Sales and Delivery	5	(3)	3	(3)	3	(3)	0	(3)	11	12
Others	2	(2)	2	(2)	1	(2)	4	(2)	9	10
TOTAL	24		22		22		23		91	100

χ^2 21.92 > χ^2 .05 21.03

$\therefore$ Reject Hypothesis

TABLE 13.--Most frequently lodged complaints about customer service.

Response	Job Classification									
	I		S		W		M			
	O	E	O	E	O	E	O	E	Total	Per Cent
Price	15	(12)	8	(11)	9	(11)	13	(11)	45	49
Inefficient Delivery Service	7	(8)	11	(8)	9	(8)	5	(8)	32	35
Others	2	(4)	3	(4)	4	(4)	5	(4)	14	15
TOTAL	24		22		22		23		91	100

χ^2 6.26 < χ^2 .05 12.59

$\therefore$ Fail to reject the Hypothesis

A chi-square test was used to see if there were a significant difference of opinion between job classifications regarding the most frequently lodged complaints against their Center. The computed chi-square was 6.26 which was lower than the critical chi-square of 12.59. The hypothesis that there is no difference of opinion between job classifications holds.

This chapter compared attitudes about customer service among job holders in the Center. Ten questions were asked of an inside salesman, an outside salesman, the warehouse manager and a company executive. In seven cases there was no difference of opinion among job holders. Differences of opinion occurred with respect to a Center's ability to give service, a Center's perceived advantage and a Center's perceived idea of their competitor's top advantage. The following chapter analyzes the findings in this chapter and Chapter V, and makes suggestions for improvements in physical distribution.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATION

Introduction

The intent in this chapter is to summarize the research findings, to make recommendations for improving physical distribution in the Metals Service Center industry, and to present suggestions for future research. Section one will draw conclusions based on the survey results presented in Chapters V and VI. Section two will analyze the existing physical distribution system. The final section presents suggestions for future research.

Physical Distribution Compared with the Maximum Performance Model

Based on the research results, Metal Service Centers are presently performing the physical distribution functions below the levels suggested in the maximum performance model. Centers are below the model for the total physical distribution systems, as well as for each of the sub-groupings--order processing, warehouse handling and transportation. The sample Centers averaged 58.79 points, which was significantly below the maximum of 111 points.

In each of the three physical distribution sub-groupings the average score was significantly below the

maximum score possible. Sample Centers averaged 1[illegible].37 points in order processing out of a possible 30 points. This difference was significant. In warehouse handling, the sample Centers averaged 16.63 points, which was significantly below the maximum of 30 points. The average score for transportation was 26.79, which is significantly below the maximum of 51 points.

Centers do their best job in warehouse handling where they average 1.66 points per physical distribution factor (see Table 1). They perform best in using standard shipping times, limiting the amount of loading done by drivers and in controlling the number of will-calls. Centers perform most poorly on warehouse costs, due to the fact that many Centers do not know their costs, and in warehouse design. In some cases the poor design is due to inadequate planning, but in many cases Centers have outgrown their present facilities.

Centers do second best on transportation where they average 1.58 points per physical distribution factor. Centers do their best job on shipping outbound tonnage by their own trucks, sound methods of acquiring their private fleet and on sound reasoning for using private transportation. They do their worst job on maximizing the weight of their trucks both in total and per stop, and in determining their customers' receiving facilities.

Centers do worst on order processing where they average 1.54 points per physical distribution factor. Centers do their best job in standardizing the arrival of the order at the Center, reducing the number of orders handled on a special basis and fast order processing. They score lowest on order processing cost, the method of order entry and on the method of controlling inventory.

In this section, then, the performance of all sample Centers was compared with the model. The next section summarized the results of the research when Centers are broken down according to two key variables, size and profit.

It will be recalled that the basic problems under research in this thesis were said to be: Does size affect the Center's physical distribution patterns? Do high profit Centers have better physical distribution systems than low profit Centers? Does the job an individual performs in the Center affect his attitude toward customer service? Three null hypotheses were set related to these specific problems. The hypotheses were:

I. No difference exists between Metal Service Centers of different size groups and the maximum performance physical distribution model.

II. No differences exist between Metal Service Centers of various profit classifications and the maximum performance physical distribution model.

III. No differences of opinion exist regarding customer service among those holding different jobs within the Metal Service Center.

The next part of this chapter presents an analysis of the research undertaken to test these hypotheses.

Hypothesis I: Size

The research results supported the hypothesis that no difference exists between Metal Service Centers of various size and the model. Small Centers received a total of 605 points, while large Centers received 806 points (see Table 14). The average score for small Centers was 55 and for large Centers the average score was 62. There was no significant difference between these two means. The point total of large Center is closer to the maximum point total of the model, and it is inferred that large Centers are more like the maximum performance model, but there was no significant difference between the mean scores.

Large Centers average higher scores than small Centers is each of the three groupings; however, there was no significant difference at the five per cent level of confidence between the average score of small Centers and the average score of large Centers, in each of these groupings. It can be noted in Table 14 that large Centers and small Centers are farthest apart in transportation and closest together in order processing.

TABLE 14.--Summary table of the points scored by sample Centers.

Physical Distribution Grouping	Sample Breakdown					
	Total Points	Average Score	Mean Score Per Factor	Total Points	Average Score	Mean Score Per Factor
	Size					
	Small			Large		
Order Processing	162	14.72	1.47	207	15.92	1.59
Warehouse Handling	172	15.64	1.56	227	17.46	1.75
Transportation	271	24.64	1.45	372	28.62	1.68
TOTAL	505	55.	1.49	806	62.	1.68
	Profit					
	Low			High		
Order Processing	196	16.33	1.63	173	14.42	1.44
Warehouse Handling	198	16.50	1.65	201	16.75	1.68
Transportation	335	27.92	1.64	308	25.67	1.51
TOTAL	729	60.75	1.64	682	56.83	1.54

In order processing, major differences between large and small Centers occur in physical distribution factors 1, 2, 5 and 6 (see Table 2). Large Centers receive a higher percentage of their orders by telephone than do small Centers. Small Centers tend to be better than large Centers in achieving an even flow of orders throughout the day. In order entry, the major differences are that large Centers rely on mechanical means such as flexi-writers and small Centers used more handwritten order entry systems. The final major area of difference in order processing is in the extent to which data processing is used. Small Centers average only one point on the extent of the use of data processing, whereas the large Centers average 1.39 points on this factor.

In warehouse handling, the major areas of difference arise in factors 17, 18 and 20 (see Table 2). Large Centers do not use drivers for loading to any great extent. Ninety-one per cent of the large Centers claim that less than 25 per cent of their drivers load their own trucks and average 2.77 on this factor. This percentage drops to 45 per cent for small Centers, which average only two points on this factor. Large Centers have fewer will-calls; seventy per cent of the large Centers said that less than five per cent of their outbound tonnage has will-calls. They average 2.46 points on this factor. Only 36 per cent of the small Centers said that less than five per

cent of their business was will-calls, and they average only 1.64 points on this factor. Small Centers do better than large Centers in warehouse costs. Small Centers average 1.36 points on this factor, while large Centers average only .69 points.

In transportation, major differences arise with respect to physical distribution factors 22, 24, 29 and 36 (see Table 2). Sixty-four per cent of the large Centers have transportation schedules set up and in use, while only 27 per cent of the small Centers have such schedules. In contrast, 54 per cent of the small Centers have no transportation schedules, while only 16 per cent of the large Centers have no schedules. The result is that large Centers average 2.31 on this factor, while small Centers average only 1.18 points on this factor. Fifty-four per cent of the large Centers use private transportation for better delivery service, whereas only 27 per cent of the small Centers use private transportation for better delivery service. Thirty-six per cent of the small Centers claim to use private transportation for lower cost while only eight per cent of the large Centers gave this reason. Fifty-four per cent of the large Centers said that less than 25 per cent of their drivers made more than one trip per day, whereas only nine per cent of the small Centers said that less than 25 per cent of their drivers made more than one trip per day. The final major

point of difference between large and small Centers is in the area of back-haul. Large Centers average 1.69 points on this factor; small Centers average only 1.36 points.

There is no significant difference between the scores of small and large Centers. Large Centers do perform better than small Centers and more closely approximate the maximum performance model. There is a tendency for large Centers to approximate more closely the model in each of the physical distribution functional areas, order processing, warehouse handling and transportation.

Hypothesis II: Profit

The research findings supported the hypothesis that no difference exists between Metal Service Centers of various profit classifications and the maximum performance model. Low profit Centers received a total of 729 points and high profit Centers received a total of 682 points (see Table 14). The average score for low profit Centers was 60.75, whereas the average score for high profit Centers was 56.83. There was no significant difference at the five per cent level of confidence between these two means.

The data in Table 14 indicates that low profit Centers do better than high profit Centers in order processing and transportation. In order processing, low profit Centers average 16.33 points while high profit

Centers average only 14.42 points. Low profit Centers average 27.92 points in transportation, while high profit Centers average 25.67 points. For the warehouse handling group, high and low profit Centers are almost even. High profit Centers average 16.75 points while low profit Centers average 16.50 points.

In order processing the main differences are in physical distribution factors 7 and 8 (see Table 3). Only two of the twelve high profit Centers were in the top one-third in terms of speed in order processing, whereas six of the twelve low profit Centers were in the top one-third in terms of speed. As a result, on factor 7, low profit Centers averaged 2.25 points while high profit Centers averaged 1.50 points , with respect to order processing cost, the lower one-third of the Centers in terms of cost were low profit Centers. Half of the low profit Centers did not know their order processing cost, whereas 66 per cent of the high profit Centers did not know these costs. Low profit Centers average 1.17 points while high profit Centers averaged .50 points.

There are few differences in warehouse handling between low and high profit Centers. Differences occur in factors 18 and 20 (see Table 3). Sixty-six per cent of the high profit Centers claimed that less than five per cent of their outbound tonnage was will-calls, and they average 2.25 points. Only 50 per cent of the low

profit Centers claimed that less than five per cent of their tonnage was will-calls, and they average 1.92 points on this factor. In the area of warehouse costs, 42 per cent of the low profit Centers do not know their warehouse handling costs as compared with 58 per cent of the high profit Centers. Low profit Centers average 1.25 on the warehouse cost factor, whereas high profit Centers only average .75 points.

The major areas of difference were factors 22, 27, 33 and 35 in transportation (see Table 3). Only two of the twelve high profit Centers were in the top one-third in terms of speed in order processing, whereas six of the twelve low profit Centers were in the top one-third in terms of speed. As a result, on factor 7, low profit Centers averaged 1.50 points. With respect to order processing costs, the lower one-third of the Centers in terms of cost were low profit Centers. Half of the low profit Centers did not know their order processing cost, whereas 66 per cent of the high profit Centers did not know these costs. Low profit Centers average 1.17 points while high profit Centers averaged .50 points.

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The major areas of difference were factors 22, 27, 33 and 35 in transportation (see Table 3). In twelve out of the seventeen physical distribution factors, low profit Centers scored as well as or better than high profit Centers. In factor 22, 25 per cent of the low profit Centers used no daily transportation schedules, whereas 42 per cent of the high profit Centers used no daily transportation schedules. In factor 27, four of the twelve low profit Centers were in the low one-third in terms of number of stops per trip while only one of the twelve high profit Centers was in the low one-third. Half of the high profit Centers had no information available about stops per trip while only one-third of low profit Centers did not know this figure. High profit Centers do a slightly better job of controlling their drivers, as they average 1.83 points on this factor, while low profit Centers average only 1.42 points. In terms of

factor 35, low profit Centers are slightly better at delivering orders on the first morning. Eight of the twelve low profit Centers were in the top two-thirds in terms of their ability to deliver orders on the first morning. Only five of the fifteen high profit Centers were in the top two-thirds.

It was anticipated that Hypothesis II would be rejected, but it was expected that high profit Centers would be significantly higher than low profit Centers. When the research was designed, the feeling was that high profit Centers would be closer to the model than low profit Centers. The reason that low profit Centers scored more points than high profit Centers may rest in the fact that Centers are in a period of heavy investment in transportation equipment, materials handling equipment, warehouse racking equipment, automated inventory controls, automated order entry and large amounts of processing equipment. Investment in these facilities would increase the efficiency of the physical distribution system; however, profit would suffer in the initial stage of investment and use. These investments, however, may provide the basis for better profits in the long run.

Based on the results of the tests in the functional areas, low and high profit Centers do not differ significantly in their relationship to the maximum performance

model. While there is no significant difference, low profit Centers tend to perform better than high profit Centers in the area of order processing and transportation.

Hypothesis III: Personnel

The research results support the hypothesis that no difference of opinion exists regarding customer service among those holding different jobs within the Metal Service Center. In seven out of the ten questions asked there was no significant difference among the job classifications.

All job classifications feel that service is important. The only variation is that top management is not as emphatic as the other three groups (see Table 4). All job groups feel that one Center can handle an order better than another, even if the product is physically identical (see Table 5).

Another approach in trying to determine the importance of customer service to various groups within the Center was to ask each respondent how he felt his Center stressed customer service. The first question asked whether or not respondents felt their company overstressed customer service, and 98 per cent felt that customer service was not overstressed (see Table 6). The second question asked if customer service was understressed, and 80 per cent of the respondents felt that customer service was not understressed (see Table 7).

While there is no significant difference between the groups in their attitude toward the amount of stress placed on customer service, it should be noted that there is a slight discrepancy between the company executives and the other three groups. The executives are in 100 per cent agreement that customer service is not understressed. Inside salesmen, outside salesmen and warehouse managers are not that convinced. It should also be noted that the executives were the least emphatic group in terms of their feeling about the importance of customer service. Forty-three per cent of the top management group replied something less than very important. The overall percentage of those replying less than very important was 21 per cent.

Sixty-eight per cent of the respondents feel that they are either above or well above their top competitors when it comes to customer service (see Table 8). For this question, there was a significant difference between the groups. The major difference arises with the inside sales group where thirteen of the twenty-four respondents felt that they were about the same as their top competitors. This is just one less response than those of all three other groups combined. Only six of the twenty-four respondents in the inside sales group felt that their Center was above their top competitor. This is below the other groups. The same is true for the response "well

above"; although, here the inside sales group is close to the other groups.

Respondents were asked what they felt were the greatest causes of delay in delivering an order to a customer when he wants it. There was no significant difference in perception among the groups. Inside salesmen seem to feel that delays occur because of scheduling, whereas the other three groups tend to feel that delays occurred because of order processing. The inside sales group has the major responsibility for order processing, and this may explain the difference (see Table 9).

There was no significant difference of opinion between groups on the question of the most important aspect of quick delivery service (see Table 10). Forty-five per cent of the respondents felt that order processing was the most important factor. The warehouse group feels that scheduling is the most important aspect, as 50 per cent of the respondents answered this way. It is noted that only 18 per cent of the warehouse group felt that the greatest cause of delay was scheduling.

There was a significant difference of opinion about the perceived competitive advantage held over top competitors (see Table 11). The major difference of opinion lies in the area of efficient delivery service. The warehouse and top management groups felt that efficient delivery service was their Center's major competitive advantage,

while the sales groups were not strongly in favor of efficient delivery service as a reason. Inside sales favored strong product line as the major advantage, while outside sales favored variety in product line. Both sales groups failed to select sales as the key competitive advantage. Inferentially, this argues well for the system's perspective. These groups seem to be thinking in terms of the total Center, not just their own department.

There also was a significant difference of opinion with regard to the competitive advantage of the Center's top competitors (see Table 12). Thirty-two of the 91 respondents felt that price was their competitor's top advantage--only one respondent felt that price had been his company's competitive advantage. Twenty-three of the respondents felt that variety in product line was their competitor's top advantage, while 16 felt that their competitor's advantage was a broad product line.

Top management does not feel that price is their competitor's big advantage, whereas the other three groups do, particularly the outside sales group. Those groups which were not strong believers in variety in product line as a competitive advantage, i.e., warehousemen and executives, tend to feel that this is an advantage of their competitors. Forty-three per cent of top management felt that efficient delivery service was their major competitive

advantage and none felt that it was a major advantage of their competitors.

The final question asked respondents what were the major complaints lodged against their Center. There was no significant difference among the groups (see Table 13). Forty-nine per cent felt that price was the customer's big complaint, this fact bearing on the view that price is the competitor's major advantage. The next most popular answer was inefficient delivery service, where 35 per cent of the respondents felt that this was the major complaint. Only two outside salesmen felt delivery service was their major advantage, and eleven felt that this is the source of most complaints. The opposite is true in the case of executives where ten felt delivery service was their major advantage and only five felt that this was the major area for complaints. Inside sales and outside sales differ in their response to this question. Sixty-three per cent of the inside sales force feel that price is the major customer complaint and 29 per cent feel it is inefficient delivery service. For outside sales, 36 per cent see price as the major cause of complaints, while 50 per cent feel that inefficient delivery is the reason. This finding could be explained by the fact that inside salesmen must haggle over price when they quote on a possible order, and outside salesmen hear about delivery delays when they make their calls.

Most Centers are aware of their responsibility to provide the customer with good, quick and efficient delivery service, and feel that the proper amount of stress is placed on customer service. There is no significant difference of opinion regarding the importance of customer service among the different job groups within the Center. Differences of opinion arise with respect to how well the respondent's Center compares with its top competitors in the area of customer service. Job groups do not agree on what their Center's major competitive advantage is nor do they agree on what their Center's top competitor's advantage is.

Analysis of the Physical Distribution Systems

Order Processing

This is the area wherein the physical distribution cycle begins. It is here where the customer's telephone call sparks the fuse which sets the distribution system in motion. Order processing patterns do not vary tremendously from one Center to another. Where variance is observed, large Centers and low profit Centers tend to be more like the maximum performance model than small and high profit Centers.

In the order processing function, the inside salesman is the focal point. This is generally the major link with the customer and very often does most of the order processing work. It is not unusual to find the inside

salesman writing the order, checking inventory, deciding whether a credit check is necessary, and sometimes even walking the order out to the warehouse. But, his job does not end here. Once the order is in the warehouse, it is tracked closely by the inside man, and if special handling is required, then this too becomes the responsibility of the inside man. He will make the decision about preference in working an order. After shipment, it is often the inside man who works with the customer on such matters as tracing, late delivery and damaged or incorrect material. Finally, it is the inside salesman who adjusts the inventory.

Orders generally arrive at the Center via telephone. When all Centers in this study are grouped together, 84 per cent said that they receive the initial order by telephone. Ninety per cent of the high profit Centers' orders arrived by telephone. All processing must be keyed from the telephone receipt of an order. It is imperative that the telephone communication system be the best system for the particular needs of the Center. If necessary, a telephone company representative should review the order receiving practices and needs of the Center, and design a system wherein customers calling in are not held waiting or disconnected, and incoming calls are routed properly.

Physical distribution systems should be designed to take care of peaking periods. A majority of Centers have periods when most of their orders arrive. In addition, the inside man's equipment should be the best available, e.g., touch-tone dialing and headsets, if necessary. It might also be possible for some telephone recording devices to be used during peak periods. Customers would call in, and their order would be recorded over the phone. A secretary could then transfer the information from the telephone tape to an order.

When the customer calls to place an order, the inside man must make some form of notation. Some Centers have the inside man make a scratch work order, then write the order himself. Others have the inside man write the order directly from the telephone; some have the inside man write up a work order from the telephone conversation and then this work order goes to an order entry clerk.

The inside man should have as much time free for selling as possible. Maximum selling time would accrue under a system whereby the inside man writes up a work order and then the order is typed, placed on a flexiwriter, or some similar practice. In addition, this would provide a neat, clear order for the warehouse to work with, and would help eliminate errors in the warehouse, like pulling the wrong material or cutting the wrong number of pieces.

Another aspect of the order processing flow which is extremely important to the efficient operation of physical distribution is inventory control. There are four aspects of inventory control which contribute significantly to the distribution process. They are: (1) the inside man must check to see if the material is on hand; (2) inventory must be reduced by the amount of the sale; (3) inventory must be adjusted after the order is shipped; and (4) mistakes, like entering an order for material which is not in the warehouse, breaks down the distribution system.

Only five of the 24 Centers interviewed used electronic data processing equipment for inventory control. Computerized inventory control will not be a panacea in all cases, but the potential for improved inventory control in this area merits more attention than is presently being given. Computerized inventory can lead to cost savings, better inventory management, more accurate record keeping, improved customer service, and better buying practices. In addition, inside salesmen can be freed from tedious, time-consuming work. For some Centers the Kardex system is fine, but for others it is time to abandon this method.

Credit checking should be done with a minimum of interruption to the order processing cycle and should be as routinized as possible. Six of the 24 Centers

interviewed said that each order was checked for credit. It seems unnecessary to run every order through a credit department. Each customer should have a credit code and credit should be checked only when that code indicates that the customer is a bad risk, has a sizeable amount outstanding, or has exhausted his line of credit. New accounts will require more time because the code has to be set up.

An area with considerable room for improvement is that of the physical movement of orders from the office to the warehouse. Some Centers still use the messenger boy type of service where the orders are placed in an "out" basket and are picked up by a messenger boy. This is all right for a small concern, but such a system suffers from time delays as the Center grows. Seventy-three minutes was the average order processing time, which leave some room for improvement.

The on-line computer order entry system represents a tremendous advancement in order processing. Under this system, the computer keeps an up-to-date record of inventory control, takes care of credit, and types the order. All of this is done in a matter of seconds.

This system holds great potential for increasing the efficiency and speed of order processing, as well as reducing its cost. Although the on-line computer order entry system will change the complete make-up of order

processing, it will require a heavy initial investment. For this reason, the metamorphosis in most Centers will be slow. It is unlikely that many Centers will be able to afford the change to on-line order entry at the present time, particularly since pre-production processing equipment is still being purchased in great numbers. In the future, on-line order entry will be more common in this industry. The movement toward computerized order entry systems will be facilitated by the development of computer time-sharing systems for this segment of the steel industry.

Warehouse Operation

The second phase of physical distribution begins when the order reaches the warehouse. The order must now be set in motion so that the material physically begins to move. This means that the orders must be selected from stock and moved to the pre-production processing area, moved from there to shipping, and then be loaded on the trucks. It is in this area perhaps that Centers have undergone the greatest amount of physical distribution change in the last ten or fifteen years. One of the major reasons that rapid change has occurred in the warehouse area has been the increase in pre-production processing. Seventy-five per cent of the Centers' order today are now processed in some fashion.

Pre-production processing is significant in that the warehouse has changed from a break-bulk, assembly, re-assembly type of operation to one which is, in part, manufacturing. This should mean production control, but very few Centers have any type of production control. Only 29 per cent of the Centers have standard processing times. This means that distribution commitments must be based on estimates of machine times. This also means that in 66 per cent of the cases, transportation is not scheduled until the order has been processed. Better production control can lead to better distribution, more efficient use of expensive machinery, improved sales and better customer service. The need for production control will become even more serious as companies expand into the "work order" business. Here Centers ship pre-processed material to a company for additional forming, galvanizing, etc., and then the Center delivers the subassembly to the final customer.

Pre-production processing has also meant that an additional operation has been added to the warehouse flow. Machines have had to be included in the warehouse design In most cases, this has resulted in processing equipment being placed in the warehouse in such a way as to facilitate the movement of goods, thus requiring that the warehouse be redesigned. Thirty-eight per cent of the Centers were judged to be poorly designed. Much of this poor design is due to the

fact that Centers have outgrown their facilities, but some is due to improperly located processing machines. Each Center should study carefully the location of each machine to determine if it maximizes material flow. Old systems, as well as new ones, should be re-evaluated.

Handling within the warehouse appears to be an area which facilitates the physical distribution activities within the Center. Most Centers rely on various types of overhead cranes for movement, the extent and variety depending upon the size of the Center. Almost two-thirds of the large Centers use either stacker cranes or side-loaders for part of their movement. One Center used an automatic stacker crane system for certain types of slow moving products.

Storage facilities in the warehouse are an aid to physical distribution. Many of the larger Centers have gone to stacker racks, which allow for the orderly, neat placement of material and provide for maximization of the use of the cube storage space in the warehouse. Likewise, many Centers have programmed their product demand and have arranged the items in inventory in such a manner that most demanded items are most easily accessible.

While the storage area itself is neat, well-equipped and facilitates the movement of goods, the shipping dock does not always accomplish these same results. Often the storage racks, while providing the storage area itself

with an elaborate system of stacker racks, are a forgotten element on the shipping dock. In many cases, material on the dock is scattered at random. Likewise, the storage area might have a beautiful system of overhead cranes, but the shipping area suffers from lack of equipment. These maladies on the shipping dock are reflected in the answers given by Centers regarding delays in shipping. Half of the respondents felt that shipping delays were related to some aspect of handling equipment or to poor facilities on the shipping dock.

Transportation

Through transportation the customer physically receives the material he desires, presumably at the time he wants it. This is the basic concept of the physical distribution system--that customers receive their orders when they need them.

In terms of total tonnage, most Centers are motor transportation oriented. This includes both inbound and outbound tonnage. A little over half of the inbound tonnage comes into Centers via motor carrier. There are certain advantages to receiving material by truck, and some Centers are geographically tied to motor transportation. Centers should study the transportation pricing by various modes and how this relates to purchasing. Perhaps there can be more use made of rail transportation, such

as piggy-back service. There may even be advantages to some form of inbound pooling with other Centers in the area.

Centers are almost completely motor transportation oriented for their outbound transportation, and most of this is private transportation. Seventy per cent of all outbound transportation moves in private transportation. Approximately 60 per cent of the Centers' outbound tonnage is delivered locally. Therefore, much of the Centers' transportation problems are related to local delivery.

The private transportation fleet of Service Centers is operated on a lease basis by a little over fifty per cent of the Centers; an additional forty per cent own their own equipment. Large Centers prefer to lease and small Centers prefer to own; however, there does not appear to be any standards by which the buy or lease decision is reached. Indeed, there appears to be some contradiction. Those who own do so because they claim it is cheaper. A favorite reply was, "Why let the leasing company make money?" Those who lease also feel that it is cheaper this way. Their reasoning is based on the opportunity cost of the capital invested in the transportation equipment.

Most of the Centers' own trucks are loaded during the night for delivery the next day. These trucks are usually gone for the day, although a few drivers in most of the Centers return for a second trip. Non-union

drivers are more likely to make the second run than union drivers. Local trucks are loaded with 12,000 to 14,000 pounds and generally make around 15 stops. Over-the-road vehicles average 30,000 pounds and make approximately 20 stops.

Most drivers who do the Centers' delivery work are unionized. Drivers generally make different runs every day, but 44 per cent of Centers responding said that their drivers make the same run every day. In roughly 80 per cent of the cases, the Center has information about the customer's delivery requirements so that the driver has his material bundled properly, knows what the receiving hours are, and knows the conditions at the consignee's. While at the consignee's, the driver generally helps with some unloading, and half of the Centers have the driver do all of the unloading. When the driver's trip is over, he may either bring a buy-out back to the Center or stop by a mill and return a mill shipment.

In roughly 45 per cent of the cases, Centers have no methods of checking on the driver's delivery time. Driver checks may not be completely useful in all circumstances, but in most cases they would seem to work for the benefit of the Center. Control over the driver's delivery time can lead to a more efficient use of the Center's fleet, give management the information it needs to determine where

changes are needed, help the Center provide better customer service and help keep the drivers honest.

Most physical distribution efforts of the Center are geared toward first day delivery, and in about half of the cases, orders are delivered by this date. Most of the orders delivered beyond the first day have pre-production processing involved, and customers know that all competitive delivery dates generally will be beyond first day.

Special handling is necessary in about five per cent of the cases to deliver an order on time. Special delivery means that some interruption in the physical distribution procedure must be made by the Center. Five per cent seems low, but this figure is an average. On some days the percentage may be high, and on other days it will be very low. Each Center should endeavor to measure the loss it will incur if special handling is not used and match this against the additional cost of special delivery. In calculating the loss, Centers should estimate the probability of the lost sale, the probability of the loss of future sales, and the probability of the loss of the account. If the marginal loss of special delivery is greater than the marginal cost, then special delivery should be undertaken.

Physical distribution plays a vibrant role in the Service Center industry. In the concluding part of this

chapter, some suggestions will be made as to how this system can be improved.

Future Research

Any research project should lead to suggestions for future research. In this thesis focus was on the total physical distribution system. Much of the suggested research is related to detailed research in more specific areas. Recommendations will be defined according to those areas with which this study was concerned, i.e., order processing, warehouse operation and transportation, plus an additional area on the complete system.

Order Processing

Each Center should make a complete study of its order entry procedure. Special emphasis here should be placed on the proper allocation of the inside salesman's time, neatness, clarity and readability of orders, speed in order processing, and cost. There appear to be many Centers which have the salesman write the order. Some Centers use a flexiwriter, others use a typist. Some Centers have four copies of the order, others ten; and, each Center has a different size order and different color combinations.

Frequently today the computer is regarded as the elixir which cures all ills. This is not the case here, however. There is too little use made of computers in

order processing. Inventory control is particularly neglected with respect to the computer. It seems that the industry has become tied into the Kardex system and is most reluctant to cut the cord. There are benefits to Kardex, but certainly there is merit in a study to delineate the advantages of computerized inventory control.

Such a study could be made by a quantitative methods man. This study could show what programs are available, how they can be implemented, what size firm can best take advantage of such programs and where benefits can be derived in terms of speed, accuracy, control, improvement in purchasing and the elimination of out-of-stock items. The problem of attracting manpower to this area is vital. Perhaps programmers will have to work for the Centers on a regional basis or through the Steel Service Center Institute.

Warehouse Operation

Centers have to take more cognizance of the effect that pre-production processing has had on their physical distribution systems. A study should be made to determine just how each Center goes about programming their orders on the various machines. Production control departments should check all orders, allocate them to various machines, and publish schedules which show the time each order was set up to be worked on each machine. Under this system, there would be a schedule for each machine for every day.

information about orders could then be distributed to all interested organizations within the Center, i.e., traffic and sales. Each part of the Center would then be aware of the status of all orders, and could work their jobs accordingly.

Pre-production processing also means new machinery for the Centers. Engineers should be consulted as to the best location for placing these machines. Such machines should be located so as to make operation as efficient as possible, imporve the flow of goods, and maximize warehouse space. In addition, the affect of "work orders" on production control should be thoroughly analyzed.

Closely associated with the above, would be engineering studies which would outline the best storage equipment to be used in the warehouse and where this equipment should be placed most effectively in the warehouse design. Included here would be appraisals of the advantages and disadvantages of handling equipment and storage equipment, and possible new devices available. For example, "What are the advantages and disadvantages of stacker racks?"; "At what point in a Center's operation will it pay them to go to stacker racks?"; "Do stacker racks actually slow down speed?"; "Is there less damage with such a system?" One can visit a Center with stacker racks and this Center will sing the praises of its system. A competitor might say that any Center would be foolish to go into a stacker rack system. What is the basis for truth here?

One particular area which needs more emphasis in terms of warehouse equipment is the shipping dock. Is there better equipment available than now in use to move goods on the dock? Can smaller stacker racks be used? How can orders be segregated on the dock? These are vital questions which need to be answered for the betterment of the Metal Service Center's distribution system.

Transportation

Many Centers fail to keep any type of distribution records in terms of transportation. Information was very limited regarding the truck weights, their composition in terms of number of shipments, where they went, what time they left and what time they returned. Such information should be kept in more detail to assist in scheduling, improve loading, develop more profitable payloads, more effectively determine the cost of transportation, make better use of drivers' time, and assist the sales and customer service departments.

A study should be made to set up standards by which Centers can make more intelligent decisions as to the value of leasing equipment over the purchase of equipment. Specific advantages and disadvantages could be set up. These criteria could then be plugged into the Center's individual situation and a well-founded decision thus reached. Such a study might also include the benefits and liabilities of certain types of equipment. Steel carriers

have the cabs centered over the frame of the truck. Because of this arrangement, structural steel, tubing, bars, etc., can be carried more easily. While these trucks facilitate handling and transportation, their used market is diminished. An equipment study could facilitate purchase decisions.

Centers can also do more in terms of setting up standard routes. The basis for setting up such routes should be the value of the customer's account. In inventory control, there is the "ABC System" of management. The "A" accounts are those which account for the largest percentage of sales. "C" accounts contribute the smallest percentage of sales and "B" accounts are those in the middle. Most Centers have a feeling for their "A" accounts and use this in matters of special delivery and pricing. An extension of this would be to set up standard routes based on some breakdown like "ABC". Of course, other subjective details have to be considered, but the "ABC" system would be the basic concept.

Standard routes would allow the Center more control over its production scheduling. Standard routes would also assist the sales department insofar as sales could be more specific in terms of their delivery schedules. In addition, the Center's orders could be combined and Centers could take maximum advantage of their fleet capacity.

Part of the last area of standard scheduling can more easily be realized by a better knowledge of what the customer really wants in terms of service. This industry has set up strict standards in the way of delivering orders quickly and Centers have occasionally gotten into competitive situations which are unprofitable, e.g., sending two men out on a truck. Customer service attitudes would not be the easiest thing to determine; however, some effort should be made in this area. Cognizance of customer needs can then be turned into more efficient packaging and perhaps different types of transportation equipment.

Physical Distribution System

An investigation might be made of the effects and necessity of setting up a customer service department. In most cases, it is the inside salesman who acts as the customer service man, but few Centers actually have a customer service department. The inside salesman could do his selling job more effectively if there were a separate customer service department. This department could keep track of the order, and provide instant information to the customer when he calls in. Such a department could, also, contact the customer, where necessary, to apprise him of the progress of his order.

Future research might include investigation of the complete inbound movement of materials. Such a study

would analyze purchasing practices in this industry, inbound transportation, receiving practices and market forecasting. There are cases where Centers buy material they cannot sell because the price is low. Some Centers fail to look at all of the total cost ramifications of inbound routing.

A study might be made regarding location theory as it applies to the Service Center industry. Most Centers are located in the heart of metropolitan areas; however, there is a trend toward the location of new distribution centers on the beltways outside large metropolitan areas, where over-the-road shipments can get in and out quickly. Such a study would also have to include the affect of labor, both blue-collar and white-collar, on the location of Centers. This labor problem could mean split facilities with the office being located in the suburbs and the plant in the center city. All of the physical distribution ramifications of such split facilities should be studied very closely.

One final area needs to be mentioned. This is distribution cost. There should be more work done in developing some information about the cost of performing the distribution functions. This cost analysis does not have to be elaborate or be done every day, but Centers should have some idea of their distribution costs. This information should be available not so much to be used as a basis

for pricing, but as a managerial tool. It is most difficult to make intelligent management decisions regarding physical distribution if the Center has no idea of the costs of the alternatives. Development of these costs, particularly in light of improved data processing, is not the horrendous task that many Centers make it out to be.

Metals Service Centers have set up excellent facilities for effectively distributing metals. With improved technology in the areas of order processing, transportation, materials handling, storage and inventory control, the Metals Service Center should become an even bigger factor in the distribution of metals. Increased efficiency by Centers within the next decade should enable the Centers to rise to heights unmeasured in the early stages of warehouse development.

APPENDICES

APPENDIX A

THE DATA COLLECTING INSTRUMENTS

STEEL SERVICE CENTER INSTITUTE
540 Terminal Tower (216) 241-3468 Cleveland, Ohio 44113

Robert G. Welch, President

The current doctoral student being sponsored by SSCI is Peter Lynagh who is doing a study of distribution patterns in the metals service center industry. So that he can gather data and observe service center operations, we have helped him select a number of companies to visit. Yours is one of those selected.

Sometime in the near future, Peter will contact you to set a mutually convenient time for him to visit. He will want to first gather some general information about your company. Then, he wants to talk with you briefly and with the people in your company who are responsible for the assembly, packaging and delivery of orders. Everything he learns will be treated confidentially and will not be used in any manner which would permit identification with your company.

Your welcoming Peter and your cooperation in helping him get the kind of information he seeks will contribute in a major way to the validity of his work and in helping to produce a dissertation which is meaningful to the industry.

Sincerely,

Robert G. Welch

DATA SHEET

All information will be held in strict confidence. Once this is returned, a Q-number will be assigned, and the cover sheet destroyed.

Q_____

Net Sales:

Less than a million _____
One million but less than five million _____
Five million but less than ten million _____
Ten million or more _____

Net profit before taxes as a per cent of net sales:

8% and above _____
6% but less than 8% _____
4% but less than 6% _____
2% but less than 4% _____
Less than 2% _____

Total number of people employed: _____

Number employed:
Inside salesmen _____
Outside salesmen _____
Office clerical _____
Schedulers _____
Warehouse _____
Processing _____
Packing and shipping _____
Transportation _____
Management _____

Do you specialize in any types of metals? Yes ___ No ___

If answer was yes, please list the special types, and the approximate percentage of the annual sales volume which is accounted for by those special types:

_____

_____

_____

Approximately how many items do you keep in inventory? _____

What is the dollar value of inventory on hand?

_____

What method do you use to determine the value?

_____

What % of your orders are pre-processed? _____

What % of your orders are shipped direct from stock without any additional work? _____

What % of your orders are shipped direct from stock without any work but cutting to length? _____

Approximately how many accounts do you service? _____

Describe briefly the geographical limits of your market.

_____

_____

What % of your orders are delivered in the metropolitan area where your plant(s) is/are located?

_____

Sq. feet of space in your operation _____

Sq. feet of space in office _____
Sq. feet of inventory space _____
Sq. feet of pre-processing space _____
Sq. feet of packing and shipping _____

I. COMPANY OFFICER

1. Number of items shipped per year _____

2. Total annual tonnage _____

3. Number of days worked _____
Number of shifts each day _____

4. Number of employees each shift _____

5. Basic jobs done by each shift:

Shift 1 _____

_____

Shift 2 _____

_____

Shift 3 _____

_____

6. Are your employees unionized? Yes ____ No ____

7. Company policy on customer service: _____

_____

_____

_____

8. Minimum charge per order: _____

9. What does it cost to: (Per item or per order)

a. Process an order (from receipt until it goes to the warehouse)_____

b. Schedule selection and transportation _____

c. Select the order and transfer it to shipping

_____

d. Packing _____

e. Loading _____

f. Transportation: Per Mile _____
Per CWT _____
Per Ton _____

10. Do you make money processing:

    a. Cutting Yes ____ No ____

    b. Slitting Yes ____ No ____

    c. Burning Yes ____ No ____

    d. Shearing Yes ____ No ____

    e. Others Yes ____ No ____

    IF NO ABOVE:

11. Why do you do it? _____

    _____

12. Who does your purchasing? _____

13. Do you lease or own your equipment? Lease ___ Own ___

14. Why do you prefer this method? _____

    _____

    _____

15. Who makes the investment decisions? _____

    _____

16. Who makes the investment decision on materials handling? _____

    _____

    _____

17. Dollar value of money invested in:

    a. Transportation EQ _____

    b. Material Handling _____

    c. Pre-Processing _____

18. Paperwork available:

Company Annual Report	_____	P & L Statement	_____
Order Blank	_____	Inside Sale Work Sheet	__
Company Stock List	_____	Balance Sheet	_____
Transportation Ton. Rept.	__	Truck Trip Tickets	_____
Others	_____		

II. ORDER PROCESSING

1. Approximate number of orders handled in one day:

   a. By Telephone _____
   b. By Mail _____
   c. Other _____

2. Check below the time period when a majority of your orders arrive:

8-10 AM	_____	1-3 PM	_____
10-12 AM	_____	3-5 PM	_____
After 5 PM	_____		

3. What is your inventory control procedure? _____

_____

_____

4. Do you check orders for credit purposes? Yes___ No___

   If Yes, what is the procedure for checking credit?

_____

_____

5. What is the average time it takes to process an order, i.e., from the time it arrives by phone until it reaches the warehouse? _____

_____

5(b) Fastest time you can process an order: _____

6. What % of your daily orders are Will Calls? _____

7. What percentage of your daily orders require special handling (non-standard delivery date, needs material today, rush, hot)? _____

8. Who makes the decision as to whether the order gets special handling?

Inside salesman _____ Vice-President _____
Office Manager _____ President _____

Other _____

9. How much do you feel the cost of processing an order is increased by special handling?

No increase _____ 10-15% _____
0-5% _____ Over 15% _____
5-10% _____

10. What is the average number of calls received in one day? _____

11. Average number of items per order _____

12. Describe briefly the procedure followed in getting an order from the telephone to the warehouse. Chart out a flow chart of the order.

_____

_____

_____

_____

_____

_____

13. Type of form used: _____

14. Extent of the use of Data Processing _____

_____

_____

15. Are the Inside Salesmen broken down by:

a. Products Yes ___ No ___
b. Customers Yes ___ No ___

16. When is the invoice sent to the customer? _____

17. Does the Inside man handle claims? Yes ___ No ___

If Yes, do you see a danger here? _____

18. Does the Inside Salesman place the location of the material on the order? Yes ___ No ___

If No, who does? _____

19. Are slot assignments: Fixed _____ Variable _____

III. SCHEDULING

1. Number of bays in warehouse _____

2. Material in each bay _____

_____

_____

3. Number of different jobs in the warehouse _____

4. Types of jobs in the warehouse _____

_____

5. Do you have a man who does nothing but schedule selection and transportation? Yes ___ No ___

If No, who does you scheduling? _____

6. Do you have set daily transportation schedules? Yes ___ No ___

7. Do you find that most customers desire early morning deliveries? Yes ___ No ___

If Yes, how do you handle the problem of scheduling all orders for AM delivery?

_____

_____

8. What procedures are followed when an order is expedited? _____

_____

9. How does pre-processing affect scheduling? _____

_____

10. Are there standard pre-processing times? Yes___ No ___

11. Do you have to wait until pre-processing is over to schedule transportation? Yes ___ No ___

12. How long does it take to process an average order through the warehouse? _____

Time for:
Cutting to Length _____
Slitting _____
Burning _____
Shearing _____

13. Describe briefly the procedures followed in scheduling a routine order for selection, packing and transportation.

_____

_____

_____

14. Describe routing for pre-processed order. _____

_____

_____

15. What is the % increase in scheduling due to special handling?

No increase _____ 10-15% _____
0-5% _____ Over 15% _____
5-10% _____

IV. SELECTING

1. Do you have special times during the day or special shifts for selecting? Yes ___ No ___

If Yes, what is the time or shift? _____

2. Does pre-processing effect selection? Yes ___ No ___

If Yes, briefly explain. _____

_____

3. Would this answer change if cutting to length was not included in pre-processing? Yes ___ No ___

4. How does the material move in the warehouse? _____

_____

4. What equipment is used to move material:

	Number	Weight Capacity
Regular Fork-Lift Trucks	_____	_____
Side-Loader Fork Lifts	_____	_____
Stacker Cranes	_____	_____
Overhead Cranes	_____	_____
Push Carts	_____	_____
Dollies	_____	_____
Others	_____	_____
	_____	_____
	_____	_____
	_____	_____
	_____	_____

6. What is the % increase in selection due to special handling?

No increase _____ 10-15% _____
0-5% _____ Over 15% _____
5-10% _____

7. Warehouse Design: (Over)

8. Is warehouse laid out well? Yes___ No ___

9. Does material flow well? Yes ___ No ___

V. PACKING AND SHIPPING

1. What percentage of your daily orders require some form of packing? _____

2. What percentage of your daily orders require some protective package for the product itself? _____

3. Do you use special personnel for packing and shipping? Yes ___ No ___

4. Does the driver help load his own truck? Yes___ No___

5. Is there a special time of day or a special shift for packing and shipping your own truck? Yes___ No___

If Yes, what is the time/shift? _____

6. Is there a special time for packing and shipping common carrier shipments? Yes ___ No ___

If Yes, explain _____

7. Does it take more time to load a shipment on a customer's own vehicle? Yes ___ No ___

   If Yes, what is the percentage increase over the time it takes to load your own company's trucks? _____

8. What causes the greatest delay in packing and shipping an order? _____

9. What is the % increase in packing and shipping due to special handling:

No increase	_____	10-15%	_____
0-5%	_____	Over 15%	_____
5-10%	_____		

10. Do you make shipments to branch plants? Yes___ No ___

    If Yes, how is this handled? _____

    _____

    _____

11. How is material loaded when there is heavy and light material or fragile and non-fragile material in the same order or trip?

    _____

    _____

    _____

12. For split orders, how are they grouped?

    Parts of the order move to a central location ___
    Truck is moved from bay to bay _____

13. Would the same answers in 12 apply for common carrier shipments? Yes ___ No ___

    If No, explain. _____

    _____

IV. TRANSPORTATION

1. What is the percentage breakdown, by mode of transportation, of the yearly outbound and inbound tonnage of your company?

	Inbound	Outbound
Railroad	%	%
Piggy Back	%	%
Truck - CC	%	%
Air	%	%
Private auto, bus or taxi	%	%
Water	%	%
Will Call	%	%
Truck - Own	%	%
Others	%	%

1(a) Have these percentages changed significantly in the last 10 years? Yes ___ No ___

If Yes, explain. _____

_____

2. Number of vehicles owned _____

Types: _____

_____

_____

3. Number of venicles leased _____

Types: _____

_____

_____

4. Why do you lease/own? _____

_____

_____

5. Who performs the maintenance? _____

6. If you have your own fleet: are the drivers unionized? Yes ___ No ___

7. Do you feel that having your own fleet helps sell your company? Yes ___ No ___

8. How long have you operated your own fleet? _____

9. What is the reason you decided to use your own fleet?

Poor common carriage service _____
More control over operations _____
Better delivery service _____
Lower costs _____
Others _____

10. Do you have set transportation routes? Yes___ No___

If Yes, what are these routes? _____

_____

_____

11. Do your drivers make the same run every day? Yes___ No ___

Explain answer _____

_____

12. How were these routes set up? _____

_____

_____

13. Does the driver:

a. Go out and work back _____
b. Work out to the more distant point _____

14. Do your drivers make more than one trip a day? Yes ___ No ___

15. Average number of stops per trip: Local ___ Over the Road ___

16. Average weight per trip: Local ___ Over the Road ___

17. Average mileage per trip: Local ___ Over the Road ___

18. Total mileage per year: Local ___ Over the Road ___

19. Do you have a procedure for checking on delivery time? Yes ___ No ___

If Yes, explain. _____

_____

20. Do you have a standard figure which gives you how long a trip should take based on # of stops and mileage? Yes ___ No ___

If Yes, explain. _____

_____

21. How often do you review your delivery patterns?

Daily _____ Monthly _____ Other _____
Weekly _____ Annually _____

22. Over the course of a year, what is the delivery time of:

	All Orders	Non-Processed
Same day order is received	%	%
1st Morning	%	%
2nd Morning	%	%
Beyond 2nd Morning	%	%

23. How much unloading is done by your driver?

_____ 100%
_____ 75%
_____ 50%
_____ 25%
_____ None at all

24. Do you ever send two drivers on a trip? Yes___ No ___

If Yes, how often? _____

25. Do your drivers put material away for customers? Yes ___ No ___

26. How do you determine what facilities the customer has for receiving?

_____

_____

27. What percentage of your daily orders require special delivery? _____

28. How much does special handling increase the cost of transportation?

No increase _____ 10-15% _____
0-5% _____ Over 15% _____
5-10% _____

29. Are any vehicles assigned for the exclusive use of a particular customer? Yes ___ No ___

If Yes, how many? _____

30. Does your company carry back-haul material? Yes ___ No ___

If Yes, what kind of material? _____
What particular route? _____

31. How many transportation claims are handled per year? CT ___ CC ___
Procedure: Own Truck _____

_____

CC _____

_____

32. How do you determine whether to use your own truck or a common carrier?

_____

_____

_____

_____

Q Number _____

INTERNAL QUESTIONNAIRE

DISTRIBUTION OF METALS

All information contained in this questionnaire will be held in strict confidence. No company names will be used in any way.

Please complete the following questionnaire and return it in the enclosed envelope. To insure maximum validity, please do not discuss the questions with any other members of your company.

COMPANY NAME _____

Once a Q-Number is assigned, identification will be removed.

INTERNAL CENTER QUESTIONNAIRE

Your position in the Company _____

Number of years employed by this Company _____

Number of years experience on your present job _____

What do you consider to be the major advantage your company has over its competitors? (Please check one below)

Price	_____
Sales	_____
Product Quality	_____
Efficient Delivery Service	_____
Strong Product Line	_____
Variety in Product Line	_____
Others: Explain	_____

What do you consider to be the major advantage your top competitor has over your company? (Please check one below)

Price	_____
Sales	_____
Product Quality	_____
Efficient Delivery Service	_____
Strong Product Line	_____
Variety in Product Line	_____
Others: Explain	_____

Given identical physical products, do you feel that one S.S.C. can handle an order better than another? Yes ___ No ___

Do you feel S.S.C.'s have been successful in their efforts to sell customers on letting the Center bear the cost of carrying inventory? Yes ___ No ___

Do you feel that the increase sale of imported steel has injured the competitive position of your company? Yes ___ No ___

In terms of delivering the right product to the customer as quickly as possible, how would you rate your company as compared with your top competitors?

1	2	3	4	5
Well Below	Below	About the Same	Above	Well Above

Where, in your opinion, do most delays in delivering an order occur?

Order Processing _____
Scheduling _____
Selecting _____
Packing & Shipping _____
Transporting _____

How important do you feel quick, efficient delivery service is to your company's customers?

1 Very Important | 2 Important | 3 Of Mild Importance | 4 Unimportant | 5 Very Unimportant

What do you consider to be the most important aspect of quick, efficient delivery service?

Order Processing _____
Scheduling _____
Selecting _____
Packing & Shipping _____
Transportation _____

Do you feel top management in your company overstresses customer service? Yes ___ No ___

Understresses customer service? Yes ___ No ___

What would you consider the most frequently lodged complaint customers make about S.S.C.'s?

Price _____
Sales _____
Product Quality _____
Inefficient Delivery Service _____
Small Product Line _____
Other _____

APPENDIX B

ALLOCATION OF POINTS TO SAMPLE CENTERS

ALLOCATION OF POINTS TO SAMPLE CENTERS

The model used in this thesis describes, verbally, the physical distribution system as it should be. If a sample Center perfectly matched the model, then that Center was given three points. If the sample Center was the antithesis of the model, then that Center was given zero points. The following measurement system shows the basis for the allocation of points for each physical distribution factor.

For each factor, points were allocated based on an ideal. In some cases, the Center was not performing according to the ideal, but what they were doing was appropriate for their particular organization. For example, a computer order entry system would be inappropriate for a very small, single-unit Center. In such cases, the allocation of points was based on what was appropriate for the individual Center.

Order Processing

1. How the order arrives at the Center

   3 Points - 90-100% by telephone
   2 " - 80-89.9% by telephone
   1 " - 70-79.9% by telephone
   0 " - Less than 70% by telephone

3. Flow of the incoming orders throughout the day

3 Points - Even distribution throughout the day
2 " - One time period bunching
1 " - Two time period bunchings
0 " - No knowledge of the time when orders arrive

5. Method of inventory control

3 Points - Immediate inventory adjustment by computer
2 " - Computer adjusted with print-outs
1 " - Kardex only
0 " - Handwritten files or manual files

4. Credit checking

3 Points - Credit codes set up for all accounts
2 " - Credit checks for new accounts only, poor risks and others
1 " - Credit check made on salesman's personal word
0 " - Complete credit check for all orders

5. Method of order entry

3 Points - On-line
2 " - Flexiwriter
1 " - Typewriter
0 " - Handwritten

6. Extent of the use of data processing

3 Points - Used in all major areas
2 " - Used in three areas, e.g., sales, billing and accounting
1 " - Used in two areas or less
0 " - None

7. Speed in order processing

3 Points - Fastest one-third
2 " - Middle one-third
1 " - Slowest one-third
0 " - No information on how long it takes to process an order

8. Order processing cost

3 Points - Lower one-third in terms of cost
2 " - Middle one-third in terms of cost
1 " - Upper one-third in terms of cost
0 " - Do not know their costs

9. Number of orders handled on a special basis

3 Points - Lowest one-third
2 " - Middle one-third
1 " - Highest one-third
0 " - No information

10. Decision on special handling

3 Points - Higher level than inside sales manager
2 " - Inside sales manager
1 " - Inside salesman
0 " - No particular responsibility

Warehouse Handling

11. The affect of pre-production processing on scheduling

3 Points - No affect
2 " - Affects some operations
1 " - Affects all operations
0 " - No reply

12. Degree of production control

3 Points - Have a production control department
2 " - Have someone who does the job
1 " - Have no production control department
0 " - --

13. Warehouse design

3 Points - Excellent
2 " - Good
1 " - Fair
0 " - Poor

14. Materials handling system

3 Points - Excellent
2 " - Good
1 " - Fair
0 " - Poor

15. Packing of material

3 Points - Excellent
2 " - Good
1 " - Fair
0 " - Poor

16. Standard time for shipping orders

3 Points - Most orders are shipped at one time
2 " - Some orders are shipped at one time
1 " - Shipping occurs throughout the day
0 " - No reply

17. Truck loading by drivers

3 Points - Less than 25%
2 " - 25% - 49.9%
1 " - 50% - 74.9%
0 " - 75% or more

18. Degree of will-call business

3 Points - Less than 5% of the outbound tonnage
2 " - 5% - 9.9% of the outbound tonnage
1 " - 10% - 14.9% of the outbound tonnage
0 " - 15% or more of the outbound tonnage

19. Causes of shipping delays

3 Points - Uncontrollable from a physical distribution standpoint, e.g., mechanical breakdown, pre-production processing and special packing
2 " - Fairly uncontrollable, e.g., poor personnel and poor transportation equipment
1 " - Fairly controllable, e.g., poorly assembled orders and lack of handling equipment
0 " - Controllable factors, e.g., lost material and poor shipping space

20. Warehouse costs

3 Points - Lower one-third
2 " - Middle one-third
1 " - Upper one-third
0 " - Do not know their costs

Transportation

21. Scheduling of orders for transportation prior to selection

3 Points - Yes
2 " - --
1 " - No
0 " - --

22. Use of daily transportation routes

3 Points - Daily schedules set up and used
2 " - Some schedules used
1 " - Schedules between company facilities only
0 " - No daily schedules

23. Outbound tonnage

3 Points - Over 75% via private transportation
2 " - 50% - 74.9% via private transportation
1 " - 25% - 49.9% via private transportation
0 " - Less than 25% via private transportation

24. Reason for the use of private transportation

3 Points - Better delivery service
2 " - More control over operations, flexibility
1 " - Poor common carrier service
0 " - Lower cost

25. Method of purchasing private transportation fleet

3 Points - Lease with legitimate justification
2 " - Own with legitimate justification
1 " - Lease with poor justification
0 " - Own with poor justification

26. Weight per truck

3 Points - Top one-third
2 " - Middle one-third
1 " - Lower one-third
0 " - No information available

27. Number of stops per trip

3 Points - Lowest one-third
2 " - Middle one-third
1 " - Highest one-third
0 " - No information available

28. Weight per stop

3 Points - Highest one-third
2 " - Middle one-third
1 " - Lower one-third
0 " - No information available

29. Number of trips made per day by drivers

3 Points - Less than 33% make more than one trip per day
2 " - 33% - 66.9% make more than one trip per day
1 " - 67% and higher make more than one trip per day
0 " - No information available

30. Nature of the drivers' daily trips

3 Points - Seldom make the same trip every day
2 " - Sometimes make the same trip every day
1 " - Very often make the same trip every day
0 " - Always make the same trip every day

31. Degree of unloading done by drivers

3 Points - Less than 25% done by drivers
2 " - 25% - 49.9% done by drivers
1 " - 50% - 74.9% done by drivers
0 " - 75% or more done by drivers

32. Determination of customers' receiving facilities

3 Points - Written questionnaires sent to customers
2 " - Salesmen check out customers' facilities
1 " - Depend on information from drivers
0 " - No procedure to check customers' facilities

33. Control checks on drivers

3 Points - Control devices set up such as trip sheets
2 " - Spot checks made by telephone customers
1 " - Depend on sales personnel to pick up complaints
0 " - No control devices set up

34. Orders requiring special delivery

3 Points - 1% or less
2 " - 5% - 1.01%
1 " - 10% - 5.01%
0 " - More than 10%

35. Delivery time for orders based on the percentage of orders delivered on the first morning or better

3 Points - Top one-third
2 " - Middle one-third
1 " - Lower one-third
0 " - No records kept

36. Degree of back-haul

3 Points - Buy-outs and mill purchases
2 " - Mill purchases only
1 " - Buy-outs only
0 " - No back-haul

37. Transportation costs should be minimized

3 Points - Lower one-third
2 " - Middle one-third
1 " - Upper one-third
0 " - No cost information

APPENDIX C

STATISTICAL COMPUTATIONS

STATISTICAL COMPUTATIONS

Appendix C contains a series of tables detailing the computations used in Chapters 5 and 6. There were three statistical tests used in these chapters. First, a t-test was used to see if the mean score of the sample was significantly less than the score of the normative model. The formula used was:

$$t = \frac{\bar{X}-\mu}{s}\sqrt{N}.$$ [1]

Second, a comparison was made between two sample means. The formula used here was:

$$t = \frac{\bar{X}_1-\bar{X}_2}{s_{\bar{X}_1-\bar{X}_2}}; \quad s_{\bar{X}_1-\bar{X}_2} = \sqrt{Sw\left(\frac{1}{N_1}\frac{1}{N_2}\right)}.$$ [2]

Third, a chi-square test was used in Chapter 6:

$$X^2 = \sum\frac{(O-E)^2}{E}.$$ [3]

---

[1] Details can be found in: John E. Freund and Frank J. Williams, Modern Business Statistics, (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1958), p. 233.

[2] Details can be found in: Frederick E. Croxton and Dudley J. Cowden, Practical Business Statistics, (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1960) Chapter 23.

[3] Details can be found in: Quinn McNemar, Psychological Statistics, (New York, N. Y.: John Wiley and Sons, Inc., 1960) Chapter 13.

TABLE 15.--Mean Scores of Sample Centers Compared With the Maximum Score of the Normative Model.

Sample Centers	Order Processing		Warehouse Handling		Trans-portation		Total	
	X(Points)	X^2	X	X^2	X	X^2	X	X^2
1	13	169	17	289	17	289	47	2209
2	12	144	14	196	28	784	54	2916
3	11	121	17	289	24	576	52	2704
4	15	225	16	256	19	361	50	2500
5	17	289	18	324	24	576	59	3481
6	17	289	17	289	19	361	53	2809
7	20	400	17	289	15	225	52	2704
8	13	169	16	256	24	576	53	2809
9	16	256	15	225	27	729	58	3364
10	15	225	16	256	24	576	55	3025
11	14	196	18	324	18	324	50	2500
12	16	256	20	400	25	625	61	3721
13	15	225	12	144	30	900	57	3249
14	14	196	16	256	28	784	58	3364
15	13	169	18	324	30	900	61	3721
16	16	256	22	484	28	784	66	4356
17	11	121	18	324	32	1024	61	3721
18	13	169	19	361	34	1156	66	4356
19	11	121	10	100	26	676	47	2209

TABLE 15.--Continued.

Sample Centers	Order Processing		Warehouse Handling		Trans-portation		Total	
	X(Points)	X^2	X	X^2	X	X^2	X	X^2
20	23	529	19	361	31	961	73	5329
21	16	256	11	121	28	784	55	3025
22	15	225	16	256	34	1156	65	4225
23	17	289	14	196	39	1521	70	4900
24	26	676	23	529	39	1521	88	7744
	369	5971	399	6649	643	17,779	1,411	84,941

Order Processing

$\bar{X}$ = 15.375

μ = 30

S = 3.606

$S_{\bar{X}}$ = .736

ΣX = 369

ΣX^2 = 5971

$$S = \sqrt{\frac{24 \cdot 5971 - 369^2}{24.23}} = \sqrt{12.94021} = 3.606$$

$$t = \frac{15.375 - 30}{3.606} \sqrt{24} = \frac{-14.625}{3.606} \cdot 4.06 =$$

$$-4.899 \cdot 4.06 = -19.894 > -2.069$$

TABLE 15.--Continued.

Warehouse Handling

$\bar{X}$ = 16.625

μ = 30

S = 9.695

$S_{\bar{x}}$ = 1.979

ΣX = 399

ΣX^2 = 6849

$$S=\sqrt{\frac{24 \cdot 6849-399^2}{24.23}} = \sqrt{93.75} = 9.695$$

$$t=\frac{16.625-30}{9.695} \cdot \sqrt{24} = \frac{-13.375}{9.695} \cdot 4.9 =$$

$$-1.379 \cdot 4.9 = -6.757 > -2.069$$

Transportation

$\bar{X}$ = 26.791

μ = 51

S = 4.899

$S_{\bar{x}}$ = 1

ΣX = 643

ΣX^2 = 17,779

$$S=\sqrt{\frac{24 \cdot 17,779-643^2}{24.23}} = \sqrt{23.998} = 4.899$$

$$t=\frac{26.791-51}{4.899} \cdot \sqrt{24} = \frac{-23.209}{4.899} \cdot 4.9 =$$

$$-4.737 \cdot 4.9 = -17 > -2.069$$

TABLE 15.--Continued.

Total Sample

$\bar{X}$ = 58.79

μ = 111

S = 9.274

$S_{\bar{x}}$ = 1.90

ΣX = 1411

ΣX^{2} = 84,941

$$S = \sqrt{\frac{24 \cdot 84,941 - 1411^{2}}{23 \cdot 24}} = \sqrt{86.346} = 9.274$$

$$t = \frac{58.79 - 111}{9.274} \sqrt{24} = \frac{-52.21}{9.274} \cdot 4.9 =$$

$$-5.61 \cdot 4.9 = -30 > -2.069$$

TABLE 16.--Difference Between the Mean Number of Points Scored on Order Processing of Small and Large Centers.

Sample Centers	Small		Large	
	X(Points)	X^2	X	X^2
1	13	169	11	121
2	12	144	15	225
3	17	289	17	289
4	20	400	13	169
5	16	256	16	256
6	15	225	15	225
7	14	196	16	256
8	14	196	11	121
9	13	169	13	169
10	11	121	23	529
11	17	289	16	256
12			15	225
13			26	676
	162	2454	207	3517

$\bar{X}_1 = 14.727$ $\bar{X}_2 = 15.923$ $Sw_1 = 2454-162^2 \div 11 = 68$

$N_1 = 11$ $N_2 = 13$ $Sw_2 = 3517-207 \div 13 = \underline{221}$

$Sw_1 = 68$ $Sw_2 = 221$ $Sw = 289$

$$S_{\bar{x}_1-\bar{x}_2} = \sqrt{289\left(\frac{1}{11} + \frac{1}{13}\right)} = \sqrt{2.20422} = 1.48$$

$$t = \frac{14.727-15.923}{1.48} = -.80 < -2.069$$

TABLE 17.--Difference Between the Mean Number of Points Scored on Warehouse Handling of Small and Large Centers.

Sample Centers	Small		Large	
	X(Points)	X^2	X	X^2
1	17	289	17	289
2	14	196	16	256
3	17	289	18	324
4	17	289	16	256
5	15	225	20	400
6	16	256	12	144
7	18	324	22	484
8	16	256	18	324
9	18	324	19	361
10	10	100	19	361
11	14	196	11	121
12			16	256
13			23	529
	172	2744	227	4105

$N_1 = 11$ $\quad N_2 = 13$ $\quad Sw_1 = 2744 - \frac{172^2}{11} = 56$

$\bar{X}_1 = 15.636$ $\quad \bar{X}_2 = 17.46$

$Sw_1 = 56$ $\quad Sw_2 = 141$ $\quad Sw_2 = 4105 - \frac{227^2}{13} = 141$

$Sw = 197$

$$S_{\bar{x}_1 - \bar{x}_2} = \sqrt{197\left(\frac{1}{11} + \frac{1}{13}\right)} = 1.3$$

$$t = \frac{15.636 - 17.46}{1.3} = \frac{-1.82}{1.3} = -1.40 < -2.069$$

Fail to Reject

TABLE 18.--Difference Between the Mean Number of Points Scored on Transportation of Small and Large Centers.

Sample Centers	Small		Large	
	X(Points)	X^2	X	X^2
1	17	289	24	576
2	28	184	19	361
3	19	361	24	576
4	15	225	24	576
5	27	729	25	625
6	24	576	30	900
7	18	321	28	784
8	28	784	32	1024
9	30	900	34	1156
10	26	676	31	961
11	39	1521	28	784
12			34	1156
13			39	1521
	271	7169	372	11000

$N_1 = 11$ $N_2 = 13$

$\bar{X}_1 = 24.64$ $\bar{X}_2 = 28.62$

$Sw_1 = 493$ $Sw_2 = 355$

$$Sw_1 = 7169 - \frac{271^2}{11} = 7169 - 6676 = 493$$

$$Sw_2 = 11{,}000 - \frac{372^2}{13} = 11{,}000 - 10{,}645 = 355$$

$$Sw = 848$$

$$S_{\bar{x}_1 - \bar{x}_2} = \sqrt{848\left(\frac{1}{11} + \frac{1}{13}\right)} = 2.52$$

$$t = \frac{24.64 - 28.62}{2.52} = \frac{-3.98}{2.52} = -1.58 < -2.069$$

TABLE 19.--Difference Between the Mean Number of Points Scored by Small and Large Centers.

$N_1 = 11$	$N_2 = 13$	$Sw_1 = 33.721 - 605^2 \div 11 = 446$
$\bar{X}_1 = 55$	$\bar{X}_2 = 62$	$Sw_2 = 51,220 - 806^2 \div 13 = 1248$
$\Sigma X_1 = 605$	$\Sigma X_2 = 806$	$Sw = 1694$
$\Sigma X_1^2 = 33.721$	$\Sigma X_2^2 = 51,220$	
$Sw_1 = 446$	$Sw_2 = 1248$	

$$S_{\bar{x}_1 - \bar{x}_2} = \sqrt{1694\left(\frac{1}{11} + \frac{1}{13}\right)} = \sqrt{12.833} = 3.58$$

$$t = \frac{55-63}{3.58} = -1.96 < -2.069$$

TABLE 20.--Difference Between the Mean Number of Points Scored on Order Processing of Low and High Profit Centers.

Sample Centers	Low		High	
	X(Points)	X^2	X	X^2
1	12	144	13	169
2	20	400	11	121
3	13	169	15	225
4	16	256	17	289
5	15	225	17	289
6	14	196	16	256
7	15	225	13	169
8	14	196	16	256
9	11	121	13	169
10	23	529	11	121
11	17	289	16	256
12	26	676	15	225
	196	3426	173	2545

$N_1 = 12$ $N_2 = 12$

$\bar{X}_1 = 16.33$ $\bar{X}_2 = 14.42$

$Sw_1 = 225$ $Sw_2 = 51$

$$Sw_1 = 3426 - \frac{196^2}{12} = 3426 - 3201 = 225$$

$$Sw_2 = 2545 - \frac{173^2}{12} = 2645 - 2494 = 51$$

$$Sw = 276$$

$$S_{\bar{x}_1 - \bar{x}_2} = \sqrt{276\left(\frac{1}{12} + \frac{1}{12}\right)} = \sqrt{46} = 6.782$$

$$\frac{16.33 - 14.42}{6.782} = \frac{1.91}{6.782} = .2817 < 2.069$$

TABLE 71.--Difference Between the Mean Number of Points Scored on Warehouse Handling of Low and High Profit Centers.

Sample Centers	Low		High	
	X(Points)	X^2	X	X^2
1	14	196	17	289
2	17	289	17	289
3	16	256	16	256
4	15	225	18	324
5	16	256	17	289
6	18	324	20	400
7	12	144	18	324
8	16	256	22	484
9	18	324	19	361
10	19	361	10	100
11	14	196	11	121
12	23	529	16	256
	198	3356	201	3493

$N_1 = 12$ $N_2 = 12$

$\bar{X}_1 = 16.50$ $\bar{X}_2 = 16.75$

$Sw_1 = 89$ $Sw_2 = 125$

$$Sw_1 = 3356 - \frac{198^2}{12} = 3356 - 3267 = 89$$

$$Sw_2 = 3493 - \frac{201^2}{12} = 3493 - 3368 = \underline{125}$$

$$Sw = 214$$

$$S_{\bar{x}_1 - \bar{x}_2} = \sqrt{214\left(\frac{1}{12} + \frac{1}{12}\right)} = \sqrt{9.7} = 3.10$$

$$t = \frac{16.50 - 16.75}{3.10} = -.08064 < .2069$$

TABLE 22.--Difference Between the Mean Number of Points Scored on Transportation of Low and High Profit Centers.

Sample Centers	Low		High	
	X(Points)	X^2	X	X^2
1	28	784	17	289
2	15	225	24	576
3	24	576	19	361
4	27	729	24	576
5	24	576	19	361
6	18	324	25	625
7	30	900	30	900
8	28	784	28	784
9	32	1024	34	1156
10	31	961	26	676
11	39	1521	28	784
12	39	1521	34	1156
	335	10125	308	8244

$N_1 = 12$ $N_2 = 12$

$\bar{X}_1 = 27.72$ $\bar{X}_2 = 25.67$

$Sw_1 = 773$ $Sw_2 = 339$

$$Sw_1 = 10,125 - \frac{335^2}{12} = 10,125 - 9,352 = 773$$

$$Sw_2 = 8,244 - \frac{308^2}{12} = 8,244 - 7,905 = 339$$

$$Sw = 1112$$

$$S_{\bar{x}_1 - \bar{x}_2} = \sqrt{1112\left(\frac{1}{12} + \frac{1}{12}\right)} = \sqrt{8.424242} = 2.90$$

$$t = \frac{27.92 - 25.67}{2.9} = \frac{2.25}{2.9} = .776 < 2.069$$

TABLE 23.--Difference Between the Mean Number of Points Scored By Low and High Profit Centers.

$N_1 = 12$	$N_2 = 12$	$Sw_1 = 45,625 - 729^2 \div 12 = 1338$
$\bar{X}_1 = 60.75$	$\bar{X}_2 = 56.83$	$Sw_2 = 39,316 - 682^2 \div 12 = 556$
$Sw_1 = 1338$	$Sw_2 = 556$	$Sw = 1894$
$\Sigma X_1 = 729$	$\Sigma X_2 = 682$	
$\Sigma X_1^2 = 45,625$	$\Sigma X_2^2 = 39.316$	

$$S_{\bar{x}_1 - \bar{x}_2} = \sqrt{1894\left(\frac{1}{12} + \frac{1}{12}\right)} = \sqrt{14.3485} = 3.78$$

$$t = \frac{60.75 - 56.83}{3.78} = 1.04 < 2.069$$

TABLE 24.--Compilation of the Chi-Squares Used in Chapter 6.

O	E	O-E	$(O-E)^2$	$(O-E)^2 \div E$
		Table 4		
21	19	2	4	.2105
19	17	2	4	.2353
19	17	2	4	.3253
13	18	5	25	1.3829
3	5	2	4	.8
3	5	2	4	.8
3	5	2	4	.8
9	5	4	16	3.2
0	0			
0	0			
0	0			
1	0			
				$\chi^2=6.67$
		Table 5		
24	23	1	1	.043
20	22	1	1	.045
20	22	1	1	.045
22	22	0	0	
0	1	1	1	1.
2	1	1	1	1.
2	1	1	1	1.
1	1	0	0	
				$\chi^2=3.16$

TABLE 24.--Continued.

O	E	O-E	$(O-E)^2$	$(O-E)^2 \div E$
		Table 6		
0	0	0	0	-
0	0	0	0	-
1	0	1	1	
1	0	1	1	
24	24	0	0	
22	22	0	0	
21	22	1	1	.045
22	23	1	1	.043
				$\chi^2 = .088$
		Table 7		
7	5	2	4	.80
5	4	1	1	.25
5	4	1	1	.25
0	4	4	16	4.00
17	19	2	4	.053
17	18	1	1	.056
17	18	1	1	.056
23	19	4	16	.941
				$\chi^2 = 6.41$

TABLE 24.--Continued.

O	E	O-E	$(O-E)^2$	$(O-E)^2 \div E$
		Table 8		
0	0	0	0	
0	0	0	0	
1	0	1	1	
0	0	0	0	
0	0	0	0	
1	0	1	1	
0	0	0	0	
0	0	0	0	
13	7	6	36	5.143
5	7	8	64	9.142
4	7	7	99	7.
5	7	8	64	9.142
6	10	4	16	1.600
10	9	1	1	.111
10	9	1	1	.111
11	9	2	4	.444
5	6	1	1	.167
6	6	0	0	
7	6	1	1	.167
7	6	1	1	.167
				$\chi^2=33.19$

TABLE 24.--Continued.

O	E	O-E	$(O-E)^2$	$(O-E)^2 \div E$
		Table 9		
8	10	2	4	.4
10	9	1	1	.111
8	9	1	1	.111
11	9	2	4	.444
10	6	4	16	2.667
2	5	3	9	1.800
4	5	1	1	.200
5	5	0	0	
2	3	1	1	.333
4	3	1	1	.333
3	3	0	0	1.333
1	3	2	4	.333
2	3	1	1	1.333
5	3	2	4	
3	3	0	0	
3	3	0	0	.333
2	3	1	1	1.333
1	3	2	4	.333
4	3	1	1	
3	3	0	0	
				$\chi^2=11.400$

TABLE 24.--Continued.

O	E	O-E	$(O-E)^2$	$(O-E)^2 \div E$
		Table 10		
10	11	1	1	.091
10	10	0	0	
7	10	3	9	.900
13	11	2	4	.364
8	8	0	0	
7	7	0	0	
11	7	4	16	2.286
3	8	5	25	3.125
3	2	1	1	.500
3	2	1	1	.500
1	2	1	1	.500
1	2	1	1	.500
3	4	1	1	.250
2	3	1	1	.333
3	3	0	0	
6	3	3	9	3.000
				$\chi^2=12.35$

TABLE 24.--Continued.

O	E	O-E	$(O-E)^2$	$(O-E)^2 \div E$
		Table 11		
3	3	0	0	
3	3	0	0	
3	3	0	0	
4	3	1	1	.333
2	2	0	0	
3	2	1	1	.500
4	2	2	4	2.000
0	2	2	4	2.000
4	7	3	9	1.286
2	6	4	16	2.667
10	6	4	16	2.667
10	7	3	9	1.286
1	5	4	16	3.200
7	4	3	9	2.250
3	4	1	1	.250
6	4	2	4	1.000
7	4	3	9	2.250
4	3	1	1	.333
2	3	1	1	.333
1	4	3	9	2.250
7	4	3	9	2.250
3	3	0	0	
0	3	3	9	3.000
2	3	1	1	.333
				$\chi^2=30.29$

TABLE 24.--Continued.

O	E	O-E	$(O-E)^2$	$(O-E)^2 \div E$
		Table 12		
8	8	0	0	
11	8	3	9	1.125
9	8	1	1	.125
4	8	4	16	2.000
5	4	1	1	.250
5	4	1	1	.250
3	4	1	1	.250
3	4	1	1	.250
4	6	2	4	.667
1	6	5	25	4.167
6	6	0	0	
12	6	6	36	6.000
5	3	2	4	1.333
3	3	0	0	
3	3	0	0	
0	3	3	9	3.000
2	2	0	0	
2	2	0	0	
1	2	1	1	.500
4	2	2	4	2.000
				$\chi^2=21.92$

TABLE 24.--Continued.

O	E	O-E	$(O-E)^2$	$(O-E)^2 \div E$
		Table 13		
15	12	3	9	.750
8	11	3	9	.818
9	11	2	4	.363
13	11	2	4	.363
7	8	1	1	.125
11	8	3	9	.500
9	8	1	1	.715
5	8	3	9	1.125
2	4	2	4	1.000
3	4	1	1	.250
4	4	0	0	
5	4	1	1	.250
				$\chi^2=6.26$

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