

EVALUATION OF ALTERNATIVE EGG
DISTRIBUTION CHANNEL SYSTEMS

Thesis for the Degree of Ph. D.
MICHIGAN STATE UNIVERSITY
JAMES G. VERTREES

1970



This is to certify that the

thesis entitled

Evaluation of Alternative Egg
Distribution Channel Systems

presented by

James G. Vertrees

has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Agricultural Economics

A handwritten signature in cursive script, reading "Henry E. Lenz".
Major professor

Date Fall, 1970

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ABSTRACT

EVALUATION OF ALTERNATIVE EGG DISTRIBUTION CHANNEL SYSTEMS

By

James G. Vertrees

Significant changes are occurring in the structure of the shell egg industry. Primarily these changes relate to size of industry firms, and the degree of coordination of production input suppliers, processors, and marketers. All indications are that the industry is trending toward fewer, larger, and more closely coordinated firms at all levels of the production and marketing processes.

Considerable research has been focused upon egg production, assembly, and processing, but that segment of the marketing channel from point of processing to final retail outlet has not been thoroughly examined. As production and processing become located together in closer geographic proximity, the major movement of shell eggs will be in distribution channels from point of processing to retail outlets in urban markets. The current study was directed at estimating and comparing the distribution costs among alternative distribution channel systems in a large urban market. This study attempted to answer such questions as:

- (1) What factors affect costs among alternative distribution

channel systems? (2) What is the effect of administrative and exchange coordination upon distribution channel costs? and (3) What is the effect of instability in trading relations between firms upon channel costs?

The general procedure used sought to obtain the specifications and the estimations of distribution costs of alternative distribution channel systems. The primary distribution costs were transportation, warehousing, and communications. The urban market focused upon was the Detroit SMA. A large food chain integrated into egg processing provided considerable primary data. The present channel system and potential systems for this firm were evaluated. From primary and secondary data, synthetic large-scale independent channel systems were evaluated. Comparison of costs among channel systems focused upon the major factors causing variations in these systems.

For the food chain administratively coordinating egg flow, the present channel entailed the movement of eggs from the processing plant to a distribution center in the Detroit SMA. From the distribution center, eggs were distributed to stores with other products. By use of the Lockset method of sequential programming for routing delivery vehicles, an alternative direct delivery system was evaluated. In this system, eggs were delivered direct to stores from the egg processing plant in south central Michigan. The advantages of direct delivery included less quality

deterioration due to faster delivery and less handling. Average distribution costs between the two channel systems were similar. But the initiation of direct delivery was found to be constrained by: (1) the fact that the present egg system was an integral part of the total distribution system operating from the distribution center; (2) the bypassing of the distribution center would remove the contribution to warehouse operating costs from eggs; and (3) tradition. The integrated food chain was not flexible in terms of being able to change the egg distribution operation at the expense of affecting the total distribution system.

For the large-scale independent channel system in which an egg processor and a food chain were linked by the exchange process, the distribution channel cost was found to be the same as the cost in the integrated channel. This cost relation was highly dependent upon a stable trading relation between the egg processor and the food chain. As the volume of eggs taken from the processing firm by the food chain decreased from a normal level of purchases, channel system cost increased as the processing firm experienced a reduction in output taken by its major customer but not a corresponding decrease in plant and delivery costs.

This study indicated that a major advantage of vertical integration through ownership--the improved coordination of the rate, amount and quality of egg flow--

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could be forthcoming for firms who are linked together through the market exchange process in distribution channel systems. Instability in trading relations between firms tended to increase channel costs and consequently reduce the ability of firms to gain the advantages of close coordination. This study suggested an important area for additional research which encompasses such facets as types of contractual arrangements between egg firms and buyers, the legality of alternative contractual arrangements, and the distribution of benefits among firms in channel systems.

EVALUATION OF ALTERNATIVE EGG DISTRIBUTION
CHANNEL SYSTEMS

By

James G. Vertrees

A THESIS

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for the degree of

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Department of Agricultural Economics

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CHAPTER I

INTRODUCTION

The Problem Situation

Significant changes are occurring in the structure of the market egg industry. Major changes are developing in each stage of the total production and marketing channel from production to final retail outlets. These changes relate to the size of industry firms and the degree of coordination of supply, production input needs, processing, and marketing [36].

The National Commission on Food Marketing (NCFM) reported a trend toward the formation of large-scale specialized egg producing units resembling factory production systems [31]. Specialized egg producing or distributing firms, feed manufacturers and, in some cases, food chains have developed and are operating such units. The NCFM predicted that new technology, which can usually be implemented more advantageously in large-scale enterprises, would encourage the further growth in the number and size of large specialized egg producing units. The NCFM also projected the development of fewer and larger firms in the processing and distribution stages. The trends toward increasing firm size and concentration of production, processing, and

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distribution in fewer and larger firms are related to the major advantages of large-scale firms:

. . . Efficiencies in physical production, processing, and distribution appear to be associated with centralized control and coordination of vertical and horizontal functions in a single large-scale enterprise . . . increasingly, important advantages of firms are in selling and buying. The volume, variety, and quality requirements can best be obtained from large suppliers. Moreover, large suppliers can more easily avoid becoming strongly dependent on a few principal customers or buyers within limited geographic areas [31].

Rogers [36] also predicted the development of increased firm size and concentration of the market egg industry into the hands of fewer firms by 1980.

Larzelere [24] and Rogers [36] have predicted greater coordination of the various stages of the market egg production and marketing channel. The NCFM [31] expected more widespread vertical integration through ownership or contract for the market egg industry as has occurred in the broiler industry. The NCFM reported that substantial efficiency could likely be gained from increased vertical integration in the egg industry. Integrating firms are expected to be those with capital and managerial expertise in the various processes of production, processing, and marketing. Although three food chains have integrated through ownership into egg production and processing [12], Larzelere [24] suggested that food chains are not likely to become more involved in large investments in actual production facilities because scarce capital provides a better return in other areas such as merchandise inventory.

Whether or not food chains further integrate into production and processing is also contingent upon the availability of large-scale suppliers who can provide large volumes of uniform quality eggs. Firms at the production and processing stages--including hatcheries and feed manufacturers--are most likely to become tied together through ownership and contract integration. With the exceptions of those food chains--Red Owl, National Tea, and Jewel Tea--integrated through ownership into production and processing, other forms of coordination of food chains and egg handling firms will develop. Closer coordination of some sort between retailers and egg firms will occur.

Shaffer [41] has defined the coordination system as controlling the production or physical transformation system. Coordination can take place through either the administrative or exchange processes. Vertical integration through ownership is an example of administrative coordination which occurs within a firm. Red Owl administratively coordinates the total egg production marketing channel. The use of contracts is an example of coordination via the exchange process. Markets, not necessarily competitive ones, are utilized to identify contractual relations and determine payments for services rendered. Kroger, which is integrated into egg processing, has to utilize the exchange process through the market to acquire eggs from producers. Other food chains must use the market to acquire the necessary volume and quality of eggs needed. In fact, the volume

and quality demands of mass merchandising institutions explain to a large degree why some food chains have integrated into production and processing¹ and why increased coordination is expected between firms in the production and marketing channel [31, 36].

Firms involved in egg market channels have been classified by Pedersen and Faber [32]. In general, channel firms were identified as follows:

- A. Producing. Individuals and firms whose main functions are producing eggs; however, they may perform shipping or distributing functions.
 1. Producers. Individuals or firms producing eggs.
 2. Producer-shippers. Individuals or firms who produce eggs and also ship them to distant markets to warehouses of food chains or to wholesale distributors. These firms may candle and grade eggs, and ship loose eggs or cartoned packs.
 3. Producer-distributors. Individuals or firms who produce eggs and also sell to retail outlets and consumers. Some of the eggs may be purchased from other producers,

¹In testimony before the NCFM at Minneapolis, Minnesota, August 1966, Red Owl's vice president of Merchandising and Procurement pointed this out as the major reason for its production activity.

assemblers, or wholesalers. These individuals or firms typically candle and grade eggs and deliver in loose or cartoned packs to retail outlets or consumers.

B. **Assembling.** Individuals and firms whose main function is assembling eggs. They may perform producing, shipping, or distributing functions.

1. Assembler-shippers. Persons or firms who assemble eggs from producers, grade the eggs, and ship loose eggs or cartoned packs to food chains or wholesale distributors in distant markets. Firms who assemble and pack eggs and distribute to retail warehouses or individual stores and who are located relatively close to the consuming areas they service are often referred to as assembler-distributors.

C. **Distributing.** Individuals and firms whose main function is distributing eggs to retail outlets and others. They may also perform producing, assembling, wholesaling, jobbing, and brokerage functions.

1. Wholesale distributors. Persons who receive eggs from their own production, producers, producer-shippers, and assembler shippers. They receive eggs mainly in truck lots, but may receive some in less than truck lots. They may repack, grade, or candle, and

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carton eggs. They sell loose and cartoned packs. They serve retail outlets and a variety of other outlets. They may perform wholesaling, jobbing, or brokerage functions.

- D. Retailing. All firms that sell or serve eggs to consumers, including independent retailers, food chains, milk distributors, commercial eating places, and institutional eating places.

Marketing channels for eggs from point of production to final outlets have experienced changes in structure and a definite trend towards larger firms and more direct channels exists. Rogers and Conley [38, p. 330] described current structure and trends in egg marketing channels:

In the simplest channel, eggs move directly from producer to consumer. In the most complex, eggs move from producers to country buying stations to country assemblers to city wholesale distributors to retail stores and finally to consumers. The predominant process is one in which eggs are assembled from producers by assembler-shippers who ship in truckload lots (600 or more 30-dozen cases) to wholesale distributors. These firms sell to a variety of outlets, but the most important are food chains and independent retailers. Recently there has been a tendency for large-volume producer-distributors to replace the assembler-shippers. An important variation is for the large-volume producer-distributor or assembler-shipper to serve individual retail stores directly.

Shifts in the location of grading and cartoning explain many of the changes in distribution channels. Grading and cartoning were first performed by wholesalers within urban markets. Later, with increasingly large volumes handled, food chains began performing these two activities

in their city warehouses. As a result, the food chains could bypass wholesalers and maintain closer control over the kind and quality of eggs offered to their customers. With increases in production, processing, and distribution technology, assembler-shippers, large-volume producer-shippers and producer-distributors assumed the grading and cartoning operations. The movement of these operations toward country points has been accompanied by expansion of direct deliveries to retail warehouses and stores by assembling and packing firms. Direct deliveries have meant that wholesale distributors in city market areas have been increasingly bypassed [37, p. 4]. The complexity of distribution channels serving urban markets is directly reflected in farm-to-retailer price spreads. Rogers and Conley [38, p. 333] noted:

. . . for eggs marketed in the New York market, farm-to-retailer price spreads are narrower for eggs received from nearby producing areas than for eggs received from the Midwest. . . . Spreads in Atlanta, St. Louis, San Francisco, and Los Angeles, which have substantial supplies of eggs nearby, are lower than in Washington, Baltimore, Seattle, and Denver, which do not have nearby suppliers. However, despite the large volume of eggs produced in the Midwest . . . spreads in Chicago and Cleveland are relatively wide, probably because the marketing systems serving these cities remain relatively complex.

With increasing coordination, the complexity of urban marketing channels may be reduced as firms become more closely linked.

All indications are that the structure of the market egg industry is trending toward fewer, larger, and more closely coordinated firms at all levels of the

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production and marketing channel. Coordination by the exchange process either through contracts or other means will result in closer trading relations between independently-owned firms at various levels. In terms of production-marketing channel systems, independent and integrated channels will be characterized by large-scale firms at the production, processing, and distribution levels.

The economies of size and operational efficiency of large firms in egg production, hatching, feed milling, and egg packing have been extensively studied [37]. Factors affecting the costs of these activities have been examined. By use of a simulation model McCarthy and Williams [28] demonstrated the cost advantages of large-scale egg production-marketing systems relative to smaller, more complex channels. The relationship between optimum egg plant size and production density has been identified. In general, the greater the production density for an area, the larger will be the optimum size of plant as assembly costs are smaller relative to areas where production density is not as great. For that segment of the production-marketing channel up to and including egg packing activities, considerable research and analysis has been undertaken. And in that segment the advantages of coordination of activities are known by industry firms who are aware of interrelationships between specific activities.

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That segment of the marketing channel from egg processing to final outlet has not been thoroughly investigated. Studies of this segment have been quite limited and have concerned fairly small firms [8, 10, 35]. For many industry firms the level of understanding of distribution costs is quite low [7]. Many firms view the distribution activity as something which has to be done irrespective of cost. However, this viewpoint will give way to more deliberate and careful evaluation of distribution costs by firms who remain in the industry. As production and processing activities continue to develop in close proximity in order to minimize the assembly activity,² the improved coordination of large egg firms and major buyers will be closely tied to the efficiency of egg movement from the processing to retail level. The effectiveness of an egg firm in analyzing market opportunities is related to its knowledge of the costs of alternative delivery methods. The ability of firms to evaluate costs in this segment of the marketing channel can provide for the planning of more operationally efficient movement of eggs from point of processing to outlets in urban markets. For firms involved in production-marketing systems through ownership integration, contract integration, or other forms of coordination the total channel efficiency may be improved. For

²The trend of most processing steps has been to move closer to the point of production. This trend is expected to continue. Larzelere and Sheppard [42].

firms at the processing and retail levels linked via ownership integration or market exchanges, their distribution system may compete with similar systems or with more comprehensive production-marketing systems. For these firms the efficiency of egg movement is related to their ability for planning and implementing the egg distribution activity.

Research Objectives

The primary objective is to estimate and compare the costs of moving market eggs through alternative distribution channel systems into a large urban market. This study is focused upon distribution costs of alternative methods of moving market eggs from the point of processing point to retail food stores. Although this movement represents only a segment of the total marketing channel, this segment is defined in this study as a distribution channel.³ Furthermore, a distribution channel system implies that firms involved in the distribution process are linked either through administrative (ownership) or exchange (market) processes. Large-scale integrated and independent channel systems are specified and costs estimated. In the integrated channel systems, a food chain has ownership of an egg packing plant. In the independent channel systems, each channel firm is owned separately. For both integrated and independent

³There is some justification for defining this segment as a distribution channel. As production and processing develop in closer proximity, the primary movement of eggs will be from point of processing to retail outlets.

channel systems, two types of channels are evaluated: (1) direct--eggs flow directly from processing firm to retail outlets; and (2) intermediary--eggs flow from the processing firm to an intermediary firm (wholesale distributor or food chain distribution center) and then to retail stores.

Factors affecting costs among alternative distribution channel systems are examined. The effect of administrative and exchange coordination upon channel costs is analyzed.

A secondary objective is the analysis of factors affecting costs among alternative methods of intracity delivery. An intracity delivery method is the procedure for moving eggs from a given point to a multiple number of retail outlets. Differences among methods of intracity delivery are found in the parameters of truck size, time constraint upon drivers and distance of the shipping origin from the market. This analysis indicates the importance to firms of being able to evaluate costs of alternative delivery methods.

The distribution costs evaluated are: (1) transportation, (2) warehousing, and (3) communications. Transportation cost includes: (a) line-haul which is movement from an origin to a single destination; and (b) intracity delivery which is movement from an origin to a multiple number of destinations. Warehousing cost is the cost of the specific activities performed in a warehouse: (a) receiving, (b) transfer, (c) selection, and (d) shipping.

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Communication costs include: (a) sales, (b) purchase, and (c) intracompany transfer.

General Procedure

The general procedure followed requires the specifications of the alternative distribution channel systems. The urban market focused upon is the Detroit SMA. This market was selected because of its representativeness; the availability of data; the presence of a large food chain, integrated into egg processing, which cooperated in this research; and convenience. Data concerning the Detroit market are provided by the integrated food chain and taken from secondary sources. This firm's present channel system and potential alternative channels are costed and compared. From primary and secondary data, synthetic large-scale independent channels are specified and costed. Comparison of factors which affect costs among channel systems focuses upon the relevant channel members' distribution costs.

To estimate channel costs, a model is used which employs two separate cost-estimating components. In one component, a sequential programming method is used to estimate the minimum cost of alternative methods of intra-city delivery. This cost is the delivery transportation cost in a channel system. The Lockset [40] method of sequential programming is visualized by the researcher as being an important tool for defining optimal delivery methods. The other component provides estimates of other channel costs--communications, warehousing, and line-haul.

Thesis Organization

In Chapter II the concepts of distribution channel systems and physical distribution costs are presented relative to the research framework. Chapter III is a review of relevant egg distribution cost studies. In Chapter IV the research procedure is detailed. Chapter V identifies the distribution costs--line-haul, warehousing, and communications--assumed for channel firms. Chapter VI is the analysis chapter in which the costs of alternative distribution channel systems are compared. Chapter VII presents the summary of primary results and focuses on the major implications of the research.

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CHAPTER II

CONCEPT OF CHANNEL SYSTEMS COSTS

In this chapter a discussion of distribution channel systems and physical distribution costs is presented. These aspects are then related to this analysis in a discussion of the research framework. A more comprehensive discussion of the research procedure is given in Chapter IV.

Distribution Channel Concepts

Traditional treatments of the distribution channel do not emphasize the channel as an operating system. Vaile, Grether, and Cox [43, pp. 121-124] suggested that:

A channel of distribution may be thought of as the combination and sequence of agencies through which one or more of the marketing flows moves. Each flow is a series of movements from one agency to another. . . . In its simplest form, a channel is limited to the movement of one unit of goods in one flow. . . . In its more complicated forms, the channel includes all combinations and sequences of all the agencies used in all the flows, possibly with an indication of the quantitative importance of each.

Implicit in this definition are the flows of the rights of ownership, financing, risk, information, and payment for goods and services. McCarthy [28, p. 312] defines a channel as "any sequence of marketing institutions, from producer to final user or consumer, including any number of (or perhaps no middlemen)." Kotler [22, p. 12] states that "every

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producer seeks to link together the set of intermediaries that best fulfills the firm's objectives. This set of intermediaries is called the marketing channel (also trade channel, channel of distribution)."

These definitions of the distribution channel focus on the idea that channels are composed of intermediaries which perform functions that move the product from producer to final user or consumer. Differences in kinds of flows moving through a distribution channel are identified. Bucklin [9, p. 5] developed a definition which included more emphasis on both physical product and product-title flow: "a channel of distribution shall be considered to comprise a set of institutions which performs all the activities (functions) utilized to move a product and its title from production to consumption."

In general, these more traditional definitions of distribution channels do not identify any systems orientation among channel members. Distinctions between a distribution channel and a distribution channel system have been suggested by McCammon and Little [27, pp. 321-385]. They have listed the key characteristics of distribution channel systems as:

1. The channel consists of interrelated components that are structured to produce predetermined results.
2. Members of the channel strive to achieve mutually acceptable objectives.
3. Activities performed by channel members are undertaken sequentially and thus it is logical to think of such activities as "marketing flows."

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4. A marketing channel is an open system in the sense that participation in it is voluntary. Firms enter a channel freely, subject to institutional and market constraints and withdraw with comparable ease.
5. A single enterprise usually "administers" the channel. It initiates, coordinates, and controls most or all of the activities undertaken.
6. The behavior of the channel members, particularly in a well established channel is "regulated" by a code that specifies types of acceptable competitive behavior. The occupational code consists of informally established group norms and a subtle but clear array of sanctions is used in most channels to control the behavior of participants.

Treating a distribution channel as an operating system brings into consideration the behavioral aspects of channel firms' internal and external relationships and activities. Alderson [1] analyzed the firm in a system's context as a social unit operating to survive in its environment. Wiek [44] studied the behavioral elements of channel control, conflict, cooperation, and innovativeness in market egg channel systems. In terms of the distribution channel as a unit of competition, Bowersox and McCarthy [3] state:

Traditional economic and business analysis of strategic planning has tended to focus on the behavior of the individual firms. More recent thinking suggests that total channel systems might be the more appropriate unit of analysis. This view is taken . . . because, basically, economic systems are designed to satisfy customer needs and these needs are not completely satisfied until some package of goods and/or services has moved all along a channel of distribution to users or final consumers. The members of a channel system may not think of themselves as members of a system, but nevertheless, their system will continue to exist as long as their unique combination performs more effectively than competing channels.

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The concept that a distribution channel system is a basic unit of competition suggests that present firms in the fresh shell market egg industry should think more about competing channel systems and becoming a part of an efficient channel [29].

The advantages of viewing distribution channels as systems are identified by McCammon and Little [27, pp. 321-385]:

1. This approach recognizes the fact that a channel is a purposeful and rational assemblage of firms rather than a random collection of enterprises.
2. The systems concept emphasizes the existence of cooperative, as well as antagonistic, behavior within the channel.
3. The channel is perceived as a unique social organism that reflects the hopes, goals, and aspirations of its participants.
4. The marketing channel from a systems point of view, is recognized as a basic "unit of competition"--a concept that broadens the study of economic rivalry.
5. The notion that a channel is an operating system provides a basis for identifying dysfunctions that are system generated.

The latter advantage "identifying dysfunctions that are system generated," places channel members in a position to adjust and correct their activities which create such dysfunctions. More specifically, in a channel system where some inefficiency exists such as in product flow, channel firms can identify and correct the inefficiency. The systems orientation which currently is in vogue in all areas of economic research including that of distribution channels is examined by Shaffer [41]:

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A systems orientation is the analysis of an economic activity in the context of a broader system. Such analysis would take into account feedback, sequences and externalities. The orientation is toward understanding the interdependencies and the effects which are not immediate or obvious.

A systems orientation is required to identify and analyze relevant distribution channel costs in order to compare the operational efficiency of alternative distribution channels.

Product Flow and Transaction Channels

Bucklin [9] and others have demonstrated that more than the single flow of physical product moves through the distribution channel. Bowersox, Smkay, and LaLonde [4, Chapter 3] have identified two primary flows in the marketing channel. The flows of transaction-creating efforts and physical fulfillment require coordination. Each of these flows does not necessarily move through the same network of channel intermediaries. The product flow channel contains a network of intermediaries engaged in the functions of physical movement.¹ The transaction channel consists of a grouping of intermediaries engaged in the establishment of trading. The total distribution channel is composed primarily of the flows of product and transaction.

The separation of the total distribution channel into a product flow and transaction channel does not imply

¹The product flow channel has been defined as the exchange channel [4]. The former term is employed in this research to avoid confusion with the concept of coordination by the exchange process [41].

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that either can stand alone. The separation of channel flows permits the development of specialists in each channel. For example, in the egg industry there are brokers who specialize in establishing trading and matching sellers with buyers. The NCFM [31] reported the use of brokers by some egg handlers. For hire exempt carriers [15] sell their transportation services to egg handling firms whose transport capabilities are not fully sufficient.

The conceptual separation of the distribution channel into two primary channel flows does not preclude a single firm from performing both product flow and transaction activities. For many agricultural products the separation of the distribution channel into the product flow and transaction channels is not so characteristic relative to manufactured consumer good products. In the market egg industry specialists do develop but in many cases a firm, particularly at the stages beyond initial production, performs both product flow and transaction activities. An egg processor can search out and acquire buyers and then physically move eggs to buyers with its own or leased trucks. An intermediary firm such as a wholesale distributor performs warehousing and transport activities as well as transaction creating activities. Channel specialists likely become operative when sellers have difficulty in finding buyers, particularly for uncommitted eggs, and when considerable distance exists between sellers and buyers. And in the latter case large

egg firms are likely to have sales representatives in their major market areas [31].

Separation of distribution channel flows facilitates the costing of distribution channels by the division of primary activities between and within the product flow and transaction channels. In this analysis more attention is focused on costs in the product flow channel. As shown later, certain communications costs are evaluated which have close relationships to transaction channel activities.

Functions and Objectives of the Product Flow Channel²

The five basic functions of the product flow channel are:

1. Adjustment is the creation of an assortment of goods. At some geographical point or points in this channel, goods must be concentrated, sorted, and dispersed to the next level in the product flow channel.
2. Transfer is the function which consists of the mechanics of collection and dispersement. Goods must be physically transported to achieve temporal and spatial fulfillment of product flow channel contracts.

²This, the next subsection, and the next section draw from Bowersox, Smkay, and LaLonde [4].

3. Storage occurs within the product flow channel because of a great deal of concentration, sorting, and dispersement in anticipation of future transactions.
4. Handling must occur at all points in the system through which the actual product passes. This function is more prone to duplication throughout the product flow channel than all others.
5. Communications is a two-way function. Channel communication is continuous as products are transferred, adjusted, and stored in anticipation of future transaction requirements.

In egg distribution adjustment is critical to matching the needs of consumers in large urban areas with the large supplies of eggs in concentrated production areas. This function will continue to be important. As Rogers and Conley [38, p. 365] indicated: "While large-scale integrated production-marketing firms designed to serve local markets may increase, there will still be surplus and deficit regions . . . there will continue to be local and long-distance marketing systems."

The basic objectives of the product flow channel are:

1. Minimum possible engagements. This objective encourages the least amount of possible duplication in the major functions of transfer,

handling, adjustment, and storage for the total product flow channel.

2. Maximum postponement in adjustment. This objective is aimed at retaining homogeneous concentrated lots of a product as long as possible in the exchange process. Ideally adjustment should be postponed until a firm commitment is available. This would require the concentration of the product based upon transaction anticipation and the holding of sorting and dispersement until the firm commitment is obtained. The longer the product flow channel can postpone final adjustment, the more flexible is the total exchange process.
3. Minimum massed reserves. The product flow channel should attempt to hold the minimum reserve of products consistent with the support of the transaction-creating activities.

The basic objectives can be demonstrated in market egg distribution. Minimum possible engagements require the minimum amount of transfer, handling, adjustment, and storage in the distribution channel. This objective focuses attention on the complexity of distribution channels in terms of the number of firms involved in moving the product from production to final consumer. This objective can be most satisfactorily met by direct distribution channels in

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which there is direct movement of eggs from point of production-processing to final outlet. But as noted by Rogers and Conley [38] direct channels are not always feasible due to distance, firm size, and little coordination of firms. Maximum efficiency requires that there be commitments among channel firms to move eggs in a directed fashion. For example, uncommitted eggs in a distribution channel can require considerable duplication of distribution activities in order to bring about the flow to final outlets. In terms of this objective, fully integrated production-marketing channels are in a better position to postpone adjustment until a firm commitment is obtained. In fact, when the retail firm is a part of a production-marketing channel, only slight variations in volume are required at the retail end. The objective of minimum massed reserves is extremely important to egg distribution. The highly perishable nature of the product necessitates minimum massed reserves. This characteristic of eggs is important in affecting all the objectives of the product flow channel. The perishability of eggs creates pressures on egg firms to develop planned distribution. But it can also pressure firms to move eggs to the next channel level without emphasis on the channel system as a whole.

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Performance of the Product Flow Channel

In general, the purpose of the product flow channel is to provide time and place utility. Until physical movement is completed, objectives of the transaction channel cannot be achieved.

Measures of performance in the product flow channel are:

1. Capability in time, place, and assortment performance.
2. Evaluation of total cost expenditures between alternative structures capable of achieving product flow channel objectives.

These measures can be applied to determine to what degree the physical distribution system achieves the basic product flow channel objectives. Such an evaluation must be made within the overall total distribution channel framework. For firms in a distribution channel system, restrictions of a socio-economic nature can prevent them from establishing the product flow channel which is most operationally efficient. Although a firm may desire to operate in conjunction with other channel firms, the firm will only accept risk for performance of product flow functions where such risk may be offset by potential return on investment or increased bargaining power [4, p. 4].

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Physical Distribution Costs

The functions performed in the product flow channel are closely related to the activities of physical distribution. Physical distribution has been broadly defined:

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 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 [4, p. 4].

From a managerial point of view, the roles of distribution communications and interfirm relationships in physical distribution are key factors in the development of physical distribution systems. Communications dissemination and feedback are instrumental in developing and maintaining the operation of physical distribution activities. Activities of firms in the product flow channel do not always result in an efficient physical distribution system. More than one firm in the channel provides for the possibility for duplication of specific physical distribution activities.

A firm's physical distribution system has to be integrated and balanced with other major areas of activity including production, finance, and marketing (product, price, and promotion). From a total physical distribution system context--all physical distribution activities performed in the product flow channel--it is desirable to coordinate physical distribution activities to achieve product flow

channel objectives. Coordination of product flow channel (physical distribution) activities can be done through either an exchange (market) process or administratively (within firm). The basic purpose of physical distribution activities is to create time and place utility to permit the actualization of form utility by final users. Although physical distribution activities in the product flow channel normally do not result in the transformation of the product in a physical-form sense, the creation of time and place utility must be viewed as a process of production. As a production system, how the physical distribution system is coordinated becomes relevant.

Physical Distribution Activity Centers

There are five components in a physical distribution system: (1) facility location, (2) transportation capability, (3) inventory allocation, (4) communications network, and (5) unitization.

Optimum locations of production and distribution facilities have been estimated for many firms by various techniques. Techniques for determining facility location range from simple heuristics to complex linear programming models. A large number of factors must be evaluated in location decisions.³ Location decisions can result in large

³See, for example, Edgar M. Hoover, The Location of Economic Activity (New York: McGraw-Hill Book Company, 1938). For an example of research, see John Huie, "Number, Size, and

amounts of capital being invested in geographically fixed facilities. Location decisions have an instrumental effect on a firm's flexibility in terms of alternative production-distribution operations.

Transportation is the link between facilities in a distribution channel. The flow of product through fixed facilities is based on an operable transport capability. Three factors need be evaluated in developing transport capability: (1) cost of transportation service, (2) speed of transit service, and (3) consistency of service. There are trade-offs among these factors. Within acceptable limits of cost and speed, consistency of service is of prime importance in egg distribution.

Communications in physical distribution is necessary for the coordination of product flow through the channel with the requirements of alternate levels in the channel. Achievement of product flow channel objectives and subsequently transaction channel objectives and total distribution channel objectives relies upon communications systems.

Inventory allocation is the activity concerned with balancing flow input and output. The objective is minimum possible commitment. Factors determining inventory requirements at alternative channel levels include type and volume requirements of buyers, product qualities (perishability,

Location of Beef Slaughtering Plants in Michigan" (unpublished Ph.D. thesis, Michigan State University, East Lansing, 1968).

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weight, etc.), degree to which transportation is integrated into the physical distribution system, and competitor performance. As noted, the perishable nature of fresh shell eggs results in a dichotomous situation in which firms plan and coordinate physical distribution systems or else move eggs quickly to the next channel level in an undirected manner. Unitization in the broadest sense involves materials handling, packaging, and containerization. This activity relates to problems concerning time and ease of product flow.

The five physical distribution cost centers are: (1) transportation, (2) warehousing, (3) communications, (4) inventory, and (5) unitizing, including packaging and materials handling. Trade-offs exist between cost centers. The decision of direct versus intermediary channels focuses upon the relationships between transportation and warehousing costs. An egg firm may have the option of delivering direct to retail stores or delivering to the food chain's distribution center. The firm may sell to a wholesale distributor. For the firm the costs of each option have to be evaluated in terms of the revenue received from each. Distance may limit the range of feasible direct delivery. This is a major reason for the existence of intermediary firms, either wholesale distributors or food chain distribution centers. From a distribution channel system viewpoint, there are also similar trade-offs between cost centers.

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Research Framework

In this analysis three basic distribution costs will be analyzed: (1) transportation, (2) warehousing, and (3) communications. Communications cost includes sales, purchase, and intracompany transfer costs.⁴ This is the cost of coordinating distribution activities in the product flow channel.

Egg distribution channel systems--from point of processing to retail outlet--evaluated in this study have some of the key characteristics of distribution channel systems identified by McCammon and Little [27, pp. 321-385]. In particular it is assumed that a distribution channel consists of interrelated components structured to produce predetermined results--the operationally efficient movement of eggs through the channel. Also, channel members strive to achieve mutually acceptable objectives. In a general way the primary objective is an acceptable level of profit for each channel firm. This is a facilitating assumption which tends to assure smooth functioning of the physical movement of eggs. In the integrated firm this objective emphasizes the need for efficient movement from one business unit (egg processing plant) to other business units of the firm (distribution center and retail food stores). For the independent

⁴Communications cost as used here may be somewhat outside a strict concept of a product flow channel cost. However, this view of communications cost will be used.

channel this same objective is assumed and reflects implicitly the effect of stability in trading relations between firms on distribution cost and firm profits. In this study, reference to a distribution channel implies that firms are more a "random collection of enterprises" [27, pp. 321-385] than a purposeful and rational assemblage of firms coordinated by the market exchange process as in an independent channel system.

CHAPTER III

EGG DISTRIBUTION COST STUDIES

A number of studies have been made concerning egg transportation costs for firms. But the bulk of the studies have centered on processing firms selling and delivering to small retail and institutional outlets. In many cases, egg firms have indicated they know little about egg delivery costs. Firms informally surveyed in this study generally tended to express the viewpoint that transportation is a function which has to be done regardless of cost. A study by Buck [7, p. 50] of egg marketing in Virginia reported that 75 per cent of the firms in the study did not know their egg delivery costs. This condition is characteristic of firms in other areas.

Studies of warehousing and communications costs have been quite limited. The major studies of importance concerning transportation, warehousing, and communications costs are discussed in this chapter.

Transportation Costs

Transportation costs for eggs are composed of truck costs and drivers' wages. In distribution channels, two types of transportation activities occur. Line-haul

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transportation is the transport of truckloads of eggs from an origin to a single destination. Delivery transportation is the distribution of eggs from an origin to a multiple number of stops within a given market.

Line-Haul Costs

Meredith [29, p. 20] studied costs of transporting eggs from the Midwest and South to the Northeast--particularly New Jersey--in 1962. Typical rates per case for distant shipping points to New Jersey were: Minneapolis, 90 cents; Jackson, Mississippi, 65 cents; Atlanta, Georgia, 60 cents; Charlotte, North Carolina, 45 cents. It was noted that rates from more distant points were less consistent with distance and, in some instances, failed to reflect large increases in mileage. Level of tolls, quality of equipment, drivers' wages, organization among drivers and firms, and the availability of backhaul were factors affecting transportation rates among regions. In terms of mileage zones, shipping points in the Midwest tended to have transportation rates higher than points in the same mileage zones in the South. Data from the USDA [37] collected in 1966 tended to substantiate the transportation rates cited by Meredith.

Delivery Transportation Costs

Studies of delivery transportation costs have been of three types. One type is the analysis of factors

affecting transportation costs in distribution routes. The second type study breaks down the accounting records of firms into cost components including distribution cost. A third type reports delivery costs based on estimates provided by firms. All provide distribution costs--the first provides more detail as to what factors determine delivery transportation cost.

Buck [8, pp. 3-4] studied by time and motion analysis the factors affecting route labor time and delivery costs for nine Virginia egg grading plants in 1960. This study analyzed the minutes of labor required and truck miles traveled to serve 252 outlets on fifty-four routes in terms of plant size, size of deliveries made, and type of outlet. The actual distribution costs estimated are not valid for this research due to low wage rates, smaller truck sizes, and nonmechanized materials handling relative to present day practices. However, the basic conclusions relative to volume of delivery and labor stop time relationships are meaningful. More specifically, Buck indicated that:

1. The variation in average delivery point time per dozen eggs among different types of market outlets (groceries, chain stores, wholesale receivers), was highly significant at the 1 per cent level of probability.
2. The differences among size of delivery groups in average delivery point time were highly significant.

3. Differences in the size of delivery made to various groups of market outlets were highly significant.
4. Much of the variation in labor required for deliveries to different market outlets was associated with the relative size of deliveries. Two-thirds of the variation in total delivery point time was explained by the volume of delivery made. The average delivery point time per case to groceries (5.8 cases average delivery) was 1.89 minutes; to chain stores (15.3 cases), 1.07 minutes; and to wholesale receivers (176.3 cases), .40 minutes.

Yergatian and Storey [45] studied wholesalers' egg marketing costs in Massachusetts in 1965. Delivery costs were determined for different routes by estimating labor cost from route labor time, and estimating truck operating costs for alternative truck sizes from total miles traveled in the route.¹ Weekly delivery cost per case for alternative

¹The egg delivery costs were expressed as $DC = FTC + VTC + VLC$ where DC is total delivery cost in dollars, FTC is fixed truck ownership cost, VTC is variable truck cost, and VLC is variable labor cost. Labor time was estimated by adapting data from Buck's study to Massachusetts conditions. Route delivery labor time in minutes $L = 7.41 (N) + .84 (V) + 3 (D)$ where N is number of stops in the route, V is the volume in cases, and D is total route miles. Using this equation, the authors reported that $r = .94$ and $S_{yx} = .73$ for a regression of calculated labor time in hours on actual labor time in hours on thirty-eight routes.

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types of routes ranging from 75 to 100 miles distance in length, from 6 to 12 stops per route, and for 15 cases per stop, ranged from .191 dollar per case to .238 dollar per case. The lower cost was for the largest scale of wholesaler utilizing labor and equipment more efficiently.

Raskopf and Nelms [35] studied commercial egg transportation costs in Tennessee. They determined that unit cost per case in assembling and delivering eggs varied among individual firms and groups of firms mainly because of differences in: (1) labor wage rates, (2) volume assembled or delivered, (3) truck distance traveled per unit in assembling or delivering, (4) unit output per man-hour, and (5) truck capacity and utilization. These five factors were associated with over 61 per cent of the variation in cost per case in delivering eggs. The average labor and truck cost per case for sixty-nine firms delivering eggs was .2937 dollar. The firms with lower costs averaged .1884 dollar per case cost. It should be noted that survey firms were involved in small delivery operations--the average cases delivered per stop were 5.2--and that labor wages were very low (average wage of 1.76 dollar per hour).

These previous three studies demonstrated that egg distribution cost from an origin to a multiple number of destinations is affected by:

1. Route labor time, which is primarily a function of volume, stops, and distance.²
2. Volume delivered per stop, primarily related to type of outlet.
3. Density of the market, i.e., distance between stops.
4. Efficiency of labor use.
5. Capacity and utilization of trucks.
6. Wage rates.
7. Truck operating costs.

These factors are evaluated in this research, particularly in terms of a defined urban market, and given alternative distribution channel parameters.

Two studies in Georgia determined distribution costs for egg handling firms through financial data supplied by firms. Jones and Smalley [17, p. 46] surveyed forty-six firms and reported an average distribution-to-outlet cost of .0123 dollar per dozen of .2952 dollar per twenty-four-dozen case. Jones and Thompson [18, p. 20] reported an average distribution cost of .2360 dollar per case for twelve egg handling firms. This study found that three large firms (52,000-170,000 cases annually) had a slightly higher

²This was shown also (in addition to the Massachusetts study) by route data collected by Larzelere and Baker in Michigan and Ohio. For twenty-five different routes, labor time in hours was regressed on volume, stops, and distance. The resulting equation was: labor time = .325 + .013V + .215N + .026D, where V is volume in cases, N is number of stops, and D is total miles. For this regression, $r^2 = .94$ and $S_{yx} = .99$.

distribution cost than the others. This primarily was due to higher freight costs involved in eggs shipped to distant markets. Smaller firms were involved in more local deliveries. However, local delivery in small lots can cost as much as moving eggs in 600-case lots up to 500 miles [10, p. 25].

Meredith [29, p. 26] collected transportation rates for shipments of eggs from selected New Jersey grading plants to warehouses and retail stores in 1962. He reported transportation rates of .2200 to .3000 dollar per case (30-dozen case) for movement of eggs 40 to 120 miles to warehouses. For the same distance range, retail store delivery rates ranged from .3000 to .6000 dollar per case.

One additional analytical study by A. T. Kearney and Company [19] estimated the physical distribution costs involved in moving a number of products from point of production into retail stores. Although not including egg distribution costs, the Kearney study did analyze lettuce which has similar weight and perishability properties per case as eggs. The cost of movement fifteen to twenty-five miles from a distribution center into a retail store was .1350 dollar per case of lettuce.

Warehousing Costs

A warehouse operated by an egg wholesale-distributor or a food chain's distribution center performs four basic functions. The first is the receiving of eggs from suppliers. The second is the transfer of eggs to temporary storage. The

third is the selection of the required volume of eggs to fill orders for a particular set of outlets. The fourth is shipping which includes activities associated with loading, checking, and preparation of a load for delivery. The warehouse serves as a break-bulk point where large lots of eggs are broken down into individual orders for buyers. Whether an egg wholesale-distributor or a food chain distribution center, nearly identical basic functions are performed, although not necessarily at the same costs. A number of factors affect warehousing costs. A primary set of factors relate to economies of scale and degree of mechanization in materials handling.

One study of particular importance by Yergatian and Storey [45] focused upon a number of egg wholesaling systems. In one of these systems the egg wholesaler procured graded and cartoned eggs from producers. The egg wholesaler performed four basic activities: (1) assembly-procurement, (2) warehousing, (3) sales, and (4) delivery. In Table III-1 the annual in-plant costs for an egg wholesale-distributor are broken down into warehousing, sales, and procurement costs per case. These costs were derived by allocating total costs to these activities. Allocations were made based upon assumptions concerning the proportion of total resources expended in each of the activities. The derived warehousing cost is .1081 dollar per case.

The Kearney [19] study analyzed physical distribution costs in food chain distribution centers. Using the cost

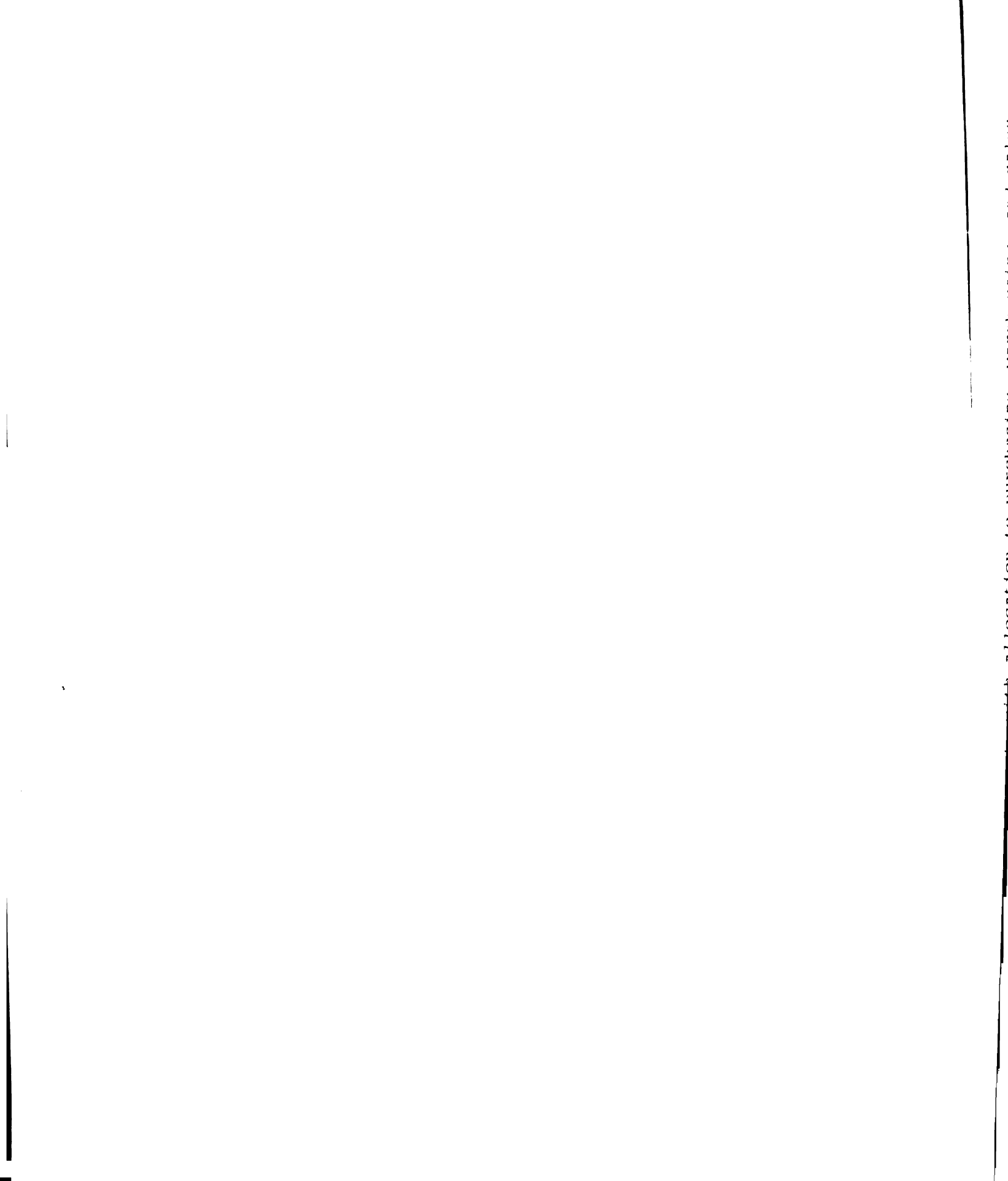


TABLE III-1.--Annual in-plant costs with allocation to purchasing, warehousing, and sales for a large-scale egg wholesale distributor.^a

Cost Item	Annual Cost ^b	Allocation to: ^c			
		Warehousing		Sales	
	(dollars)	%	(dollars)	%	(dollars)
<u>Variable Operating Costs</u>					
Shipping and receiving labor	21,070	100	21,070		
<u>Fixed Operating Costs</u>					
Management and office salaries	43,670	20	8,734	50	21,835
Miscellaneous	7,366	60	4,420	20	1,473
<u>Fixed Overhead</u>					
Depreciation	3,477	70	2,434	15	522
Interest, taxes, and insurance	4,308	70	3,016	15	646
Repairs and maintenance	1,166	70	816	15	175
Total	81,057		40,490		15,913
Cost per cased	.2165		.1081		.0423

^aAnnual throughput of 374,400 cases.

^bCosts in original study were compounded at 3.0 per cent per year (for 4 years) to be representative of 1969-70 conditions.

^cAllocations to each function made by researcher and were not made in original study.

^dMay not add to total because of rounding.

Source: Charles Yergatian and David A. Storey, Wholesaler and Egg Marketing Costs in Massachusetts--An Analysis of the Effect of Volume and Procurement System, Experiment Station/Cooperative Extension Bulletin 559 (Amherst, Mass.: University of Massachusetts, 1966).

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derived for a case of lettuce, the receiving, transfer, selection, and shipping functions averaged .1150 dollar per case.

Communications Costs

Studies of communications costs--purchase, sales, and intracompany transfer costs--have been quite limited for eggs. Purchase cost is directly related to the amount of resources expended by firms in acquiring eggs via the exchange process. Sales cost is the cost to firms of acquiring and servicing buyers in competitive markets. Intracompany transfer cost is the cost of transferring eggs internally within a firm through separate business units. For a food chain integrated into egg processing, the transfer is from egg processing plant to distribution center and/or retail store. Each stage is a business unit but within a single firm.

Considerations

A number of problems exist in trying to measure sales and purchase costs. One problem centers on the accounting systems of firms and their individual definitions of what expenditures should be allocated to these communication costs. The same type of problem exists for integrated firms in attempting to identify intracompany transfer cost. The wide range of assumptions which are made in allocating expenditures to these communication costs results in alternative

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values of these coefficients. In this case, the researcher has to make some assumptions based on knowledge of the firms and industry under study.

Qualitative measurement of the effect of specific factors on sales cost is limited. However, a priori, certain factors can be defined as affecting the level of sales cost. The basic factors affecting sales cost for a firm are: (1) size, type, and number of buyers; (2) regularity of sales to buyers; (3) size of selling firm; (4) efficiency of performance of the acquisition and servicing activities; (5) market conditions; and (6) distance of seller from his primary market. The NCFM [31] study reported that for a given retailer, regular suppliers were relied upon for most needs. Larger sellers typically dealt with more customers, and the volume sold any one customer has represented a smaller proportion of total sales for a larger seller than a small one. The data presented by the NCFM indicated that for egg firms with less than 42,000 cases sold per month, the five largest customers of each firm accounted for about 71 per cent of each firm's sales. For larger firms, 42,000 to 208,000 cases per month, the largest five customers accounted for 55 per cent of sales.

Though there may be considerable regularity in exchange between a seller and his major buyers, competition among sellers precludes a seller from continuously avoiding risk and uncertainty associated with acquiring and maintaining

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buyers. In addition, for the proportion of sales not made to regular customers, sales costs are likely to be greater. Differences in level of sales costs among firms can be attributed to all the above factors. However, given comparable market conditions, buyer characteristics, size of firm, and regularity of sales, two firms can exhibit considerable variation in sales costs due to the internal efficiency of performing the acquisition and servicing activities.

Purchase costs for egg wholesale distributors and food chains are subjected to some of the same considerations involved in sales cost determination. Size, number, and competition among sellers directly influence the purchase cost. The regularity of purchases from a given supplier and the degree to which the firm must continually seek out suppliers affect the level of purchase cost. Market conditions--the supply and demand situation--can be very instrumental in affecting a firm's purchasing costs. In a period of large supplies, a food chain may be able to gain concessions from a supplier in exchange for its business. Concessions relate to services provided by the supplier such as store door versus distribution center delivery. Conversely, in a period of short supply, the food chain may be forced to expend additional resources in order to maintain desired egg volumes. The internal efficiency which a buyer possesses in the procurement process is also a significant factor affecting the level of purchase costs.

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In egg distribution channels, the firms with greatest market power have become those at the final levels, primarily food chains. Competition among sellers for buyers tends to be more common than the converse. In general, this condition is reflected in higher unit sales cost than purchase cost for egg firms.

Studies

Chain store purchase costs and intracompany transfer costs are derived in Chapter V, independent of previous research. Processor's sales cost, wholesale distributor's sales cost and wholesale distributor's purchase cost are determined from data presented in previous research.

For a large-scale processor two sales cost estimates were derived. One estimate was based on data developed by Peeler and King [34]. Management and office personnel costs for an egg processor were allocated to sales cost as indicated in Table III-2. The sales cost estimate is .0725 dollar per case. In this instance, costs allocated to sales are only management and office costs and do not include any overhead costs. A second estimate was obtained from data from Yergatian and Storey [45] (Table III-3). Here management and office costs and fixed overhead costs were allocated to sales. The sales cost estimate is .0818 dollar per case. The firm represented by this data was of larger scale. The differences here are primarily due to the inclusion of overhead costs in the latter estimate and not so much related to

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TABLE III-2.--Annual in-plant management and office personnel costs allocated to sales for an egg processor.^a

Cost Item	Annual Cost ^b	Allocation to Sales ^c	
	(dollars)	(percent)	(dollars)
Manager	18,448	50	9,224
Superintendent	9,224	25	2,306
Foreman	6,395	--	
Secretary	4,425	50	2,213
Bookkeeper	7,379	50	3,689
Payroll clerk	<u>4,428</u>	30	<u>1,328</u>
Total	50,299		18,760
Cost per case	.1863		.0695
Office supplies cost per case	---		.0030
Total sales cost per case	---		.0725

^aAnnual capacity of 270,000 cases of eggs graded and cartoned.

^bAnnual salary estimated by compounding 1963 data by 3.0 per cent for six years to be more representative of 1969-70.

^cThis allocation made by the researcher and was not made in original source.

Source: R. J. Peeler, Jr., and Richard A. King, In-Plant Costs of Grading and Packing Eggs, Department of Agricultural Economics, North Carolina State University, A.E. Info. Series No. 106 (Raleigh, N.C.: North Carolina State University, 1963).

TABLE III-3.--Annual in-plant costs with allocation to sales for a large-scale egg processor.^a

	Annual Cost ^b	Allocation to:			
		All Other ^c		Sales	
	(dollars)	%	(dollars)	%	(dollars)
<u>Variable Operating Costs</u>					
Processing labor	94,345	100	94,345		
Shipping and receiving labor	21,070	100	21,070		
Equipment operating	11,870	100	11,870		
Variable repairs	4,986	100	4,986		
Wear depreciation	12,467	100	12,467		
<u>Constant Unit Operating Costs</u>					
Packaging materials	329,073	100	329,073		
<u>Fixed Operating Costs</u>					
Management and office salaries	51,773	50	25,887	50	25,887
Miscellaneous	8,554	80	6,843	20	1,711
<u>Fixed Overhead</u>					
Depreciation	22,175	90	19,957	10	2,218
Interest, taxes, and insurance	13,693	95	13,008	5	685
Repairs and maintenance	4,510	97	4,375	3	135
Total ^d	574,516		543,882		30,636
Cost per case ^d	1.5345		1.4527		.0818

^aAnnual production of 374,400 cases. This assumes a 75 per cent of capacity operating level and a double shift operation.

^bCosts in original study were compounded at 3.0 per cent per year for four years to be representative of 1969-70 conditions.

^cAllocations to each function were made by researcher, not in original study.

^dMay not add to total because of rounding.

Source: Charles Yergatian and David A. Storey, Wholesaler and Egg Marketing Costs in Massachusetts--An Analysis of the Effect of Volume and Procurement System, Experiment Station/Cooperative Extension Bulletin 559 (Amherst, Mass.: University of Massachusetts, 1966).

size. But economies of size in management and office operations cost have been noted [18]. These two coefficients demonstrate that the assumptions made regarding what costs and what proportion allocated to sales affect the cost coefficient derived.

Sales cost and purchase cost for a large-scale egg wholesale distributor are presented in Table III-1. This data was taken from Yergatian and Storey [45]. The sales cost coefficient is .0658 dollar per case and the purchase cost is .0425 dollar per case. These were derived assuming greater allocation of management and office costs to sales than purchase, and equal allocation to each activity of fixed overhead.

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CHAPTER IV

RESEARCH METHODOLOGY

The purpose of this chapter is to more explicitly identify the research procedure and methodology. In the first section the major facilitating assumptions and research considerations are presented. Then the cost estimating model and its two component parts--intracity delivery method cost component and the line-haul, warehouse, and communications cost component--are identified. Finally the specifications of alternative intracity delivery methods and egg distribution channel systems are given.

Major Assumptions

The three major distribution costs are transportation, warehousing and communications. Transportation cost has two parts. Line-haul is required in a channel system when eggs are not shipped direct from the point of processing to final retail stores. Therefore, when an intermediary firm is in a distribution channel system--either a wholesale distributor or a food chain distribution center--the line-haul activity is necessary. Delivery transportation cost is the cost of delivering eggs by a specific method of intracity delivery. Warehousing cost is the cost of the primary activities

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performed in a distribution center or an egg wholesale distributor's warehouse. Communications costs includes sales costs for the egg processing firm and the wholesale distributor operating as independently owned businesses. Purchase costs for the wholesale distributor and the independent food chain are also communications costs. The food chain integrated into egg processing has an intracompany transfer cost which is a communications cost necessary for the movement of eggs from the processing business unit to final retail store business units.

Both firm and channel costs are expressed as average total costs per case of eggs moving through a distribution channel system. Intracity delivery cost is estimated on the basis of the total weekly expenditures--truck and labor--by a channel firm necessary for the delivery of eggs as required by the retail food stores.

In this analysis three basic types of channel firms are identified.

1. An egg processing firm is a firm which purchases eggs from producers, has eggs produced on contract or produces part of all of its eggs. The firm grades and cartons eggs for distribution to retail stores or to wholesale distributors. A processing firm independent of wholesale distributor or retail food chain and a firm owned by a retail food chain are channel firms. Although of similar size and operating efficiency, the independent firm operates in channel systems defined as independent structures

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while the egg processing firm owned by the food chain operates strictly within an integrated channel structure. Integrated channel structure implies ownership by the food chain of both the egg processing plant and the distribution center warehouse. Independent channel structure implies separate ownership of each firm in the channel system. It does not mean there is no coordination among channel members.

2. A wholesale distributor is a firm which serves as an intermediary firm in independent channel structures. Primarily the firm purchases graded and cartoned eggs from egg processing firms. In turn the firm sells to retail food chains. In addition to the purchase and sale of eggs the firm performs the warehousing function as it balances the inflow and outflow of eggs. The firm is performing the adjustment function in the channel. The intracity delivery of eggs is also a major activity of the wholesale distributor.

3. A food chain is a large-scale firm operating a distribution center and retail food stores in the Detroit SMA. The integrated food chain (integrated into egg processing) is a firm from which considerable data were obtained. This firm is a focal point of this research. Much of the data--particularly store location, egg volume requirements and several operating practices--were assumed to be characteristic of a second food chain operating independently (no egg plant). This latter food chain purchases eggs from

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independent egg processors or wholesale distributors. In the integrated food chain the communications cost is the cost of transferring eggs internally but through separate business units. For the independent chain the purchase cost is the communications cost.

The size of channel firms is determined by the volume requirements of the retail food stores included in the analysis. The number of stores was determined by selecting most of the integrated food chain's retail stores in the Detroit SMA. Seventy-two stores were in the sample. The estimated total weekly volume of eggs required by these stores is 5400 cases. (a detailed discussion of these data is presented later in the specifications of intracity delivery methods.) Large-scale channel firms are required. Economies of scale are reflected in warehousing and communications costs. In Chapter V these costs are derived.

In the independent channel structure, coordination of egg flow is directed by the exchange process via markets. In contrast, the administrative process directs egg flow within the integrated channel system. The effect of how the movement of eggs through a channel is coordinated is reflected in communications cost for the channel. For an independent channel system, the purchase and sales costs for channel firms are, in total, the channel communications cost. In the integrated channel system, the food chain's intracompany transfer cost is the channel communications cost.

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The Model

The purpose of the model is to provide estimates of average per unit costs per week of distributing eggs in alternative distribution channel systems. There are two components to the model: (1) the intracity delivery method cost component which estimates the delivery transportation cost--truck and labor--in alternative methods of intracity delivery; and (2) the line-haul, warehouse, and communications cost component which provides estimates of line-haul, warehouse, sales, purchase, and intracompany transfer costs required in a given distribution channel system. Each component is discussed separately. Then the two are combined and the model presented.

Intracity Delivery Method Cost Component

The purpose here is to present the method employed to derive estimates of intracity delivery costs. Complete specifications of the alternative methods of intracity delivery are presented later.

An intracity delivery method is defined by a number of parameters: (1) origin from which delivery is made, (2) volume requirements per store, (3) number of stores, (4) capacity of delivery vehicles, (5) number of deliveries per week, and (6) time constraints upon drivers.

To estimate the delivery cost on a weekly average per case basis for a given delivery method required the identification of route structures and number of routes.

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Route structure is defined by the following parameters:

(1) number and identity of stores in the route, (2) volume of eggs in cases delivered to each and all stores in the route, (3) sequence of stores in the route, (4) total miles in the route, (5) total route time, and (6) identity and capacity of truck servicing the route. It is assumed that once defined, a route is run regularly as required in order to efficiently deliver eggs.

Routes are defined by the Lockset method of sequential programming. This technique for routing vehicles was developed by Leonard Schruben and associates at Kansas State University.¹ A detailed discussion of this technique is presented in the AJAE [37]. A brief discussion of the fundamentals of the Lockset method follows. The Lockset method of route selection enables delivery routes to be designed by selecting a set of stops to be included on a route and by finding a sequence for each set. The primary objective is the minimization of total distance traveled by all carriers in the analysis. This requires the minimum number of carriers. Lockset defined routes are considered reasonable-rational rather than feasible-optimal, because this technique is not deterministic in the sense of offering mathematical proof of optimization. The Lockset method tends to minimize delivery costs within the given set of parameters.

¹The author wishes to express his gratitude to Dr. Schruben for processing data for this thesis at Kansas State University.

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In essence this component reveals the effect of simulated changes in the method of intracity distribution upon delivery costs. The Lockset program is utilized as a simulator to produce physical parameters of distribution routes which are then used to derive minimum costs of alternative delivery methods. As a planning device for distribution firms the technique provides an analysis of simulated changes.

In general the Lockset program requires data inputs of the following kinds:

1. Location of stores and shipping origin.
2. Volume required per stop in cases.
3. Number and capacity of carriers (trucks) in cases.
4. Restrictions imposed on driver's maximum working time per day.
5. Distance in miles (using likely routes between the points) between the shipping origin and each stop (this distance is converted to minutes by division by the driving speed per hour).
6. Distance in miles (using likely routes between pairs) between each stop and other stops likely to be included in the same route. These are "key links" and are identified by considering each stop as the hub of a wheel with the spokes to surrounding stops the key links. This procedure does not necessitate the determination

of the distances between a stop and all other stops for all stops. (As above, the mileage figures for each key link are converted to minutes.)

7. Time required at each stop for unloading.

More explicitly, the procedure for estimating costs of alternative methods of intracity delivery is now presented.

The j th intracity delivery method, IDS_j , is identified by the following parameters:

VOL_j = number of cases required per week by all stores in IDS_j .

DEL_j = number of deliveries per week in IDS_j .

$STORES$ = number of stores in IDS_j , 72.

$STORE_h$ = the h th store, $h = 1, 2, \dots, 72$.

$WVOLS_{hj}$ = weekly volume of eggs in cases required by the h th store in IDS_j , $h = 1 \dots 72$.

$VOLS_{hj}$ = volume required per delivery by the h th store in IDS_j • $VOLS_{hj} = WVOLS_{hj} / DEL_j$.

$ORIGIN_k$ = origin from which delivery is made; $k = 1, 2$.

STS_{hj} = stop time in minutes for the h th store in IDS_j .

TS_i = size of truck used, $i = 1, 2$. Size measured in case capacity.

MAT = maximum time in minutes that a driver-truck combination can operate.

DET = miscellaneous delay time in minutes including lunch time.

D = distance in miles, converted to minutes, between two stores. There are 240 of these "key links" for the seventy-two stores.

D' = distance in miles, converted to minutes, between the origin, $ORIGIN_k$ and each of seventy-two stores. When $k = 2$, five additional D' values are required. ($ORIGIN_1$ is within the market area, but $ORIGIN_2$ is about 110 miles from the market area.) These additional values measure the distance between $ORIGIN_2$ and each of five stores closest to it. These are the only additional key link data required for the Lockset program to define routes from $ORIGIN_2$.

As shown in Figure IV-1, these structural parameters are data inputs into the Lockset program. The Lockset program defines feasible-rational routes and their associated parameters:

R_{ij} 's = routes, $i = 1, \dots, n$, defined by Lockset analysis for IDS_j .

For each R_{ij} :

S_{dij} = the d th store in the i th route of IDS_j (the sequencing of stores in the i th route). S_{dij} may be any $STORE_h$, where $h = 1 \dots 72$.

S_{ij} = total stores in the i th route of IDS_j . $S_{ij} = \sum_{d=1}^n S_{dij}$; this implies that all stores in the route, starting with the first, are added to get the total route stores.

$VOLS_{dij}$ = volume in cases delivered to the d th store in the i th route of IDS_j . The d th store can be any $STORE_h$, $h = 1, 2 \dots 72$.

VOL_{ij} = volume in cases delivered in the i th route of IDS_j .

$$VOL_{ij} = \sum_{d=1}^n VOLS_{dij}.$$

STS_{dij} = stop time in minutes for the d th store in the i th route of IDS_j . The d th store can be any $STORE_h$, $h = 1, 2 \dots 72$.

TST_{ij} = total stop time in minutes in the i th route of IDS_j .

$$TST_{ij} = \sum_{d=1}^n STS_{dij};$$
 a direct output of the Lockset program.

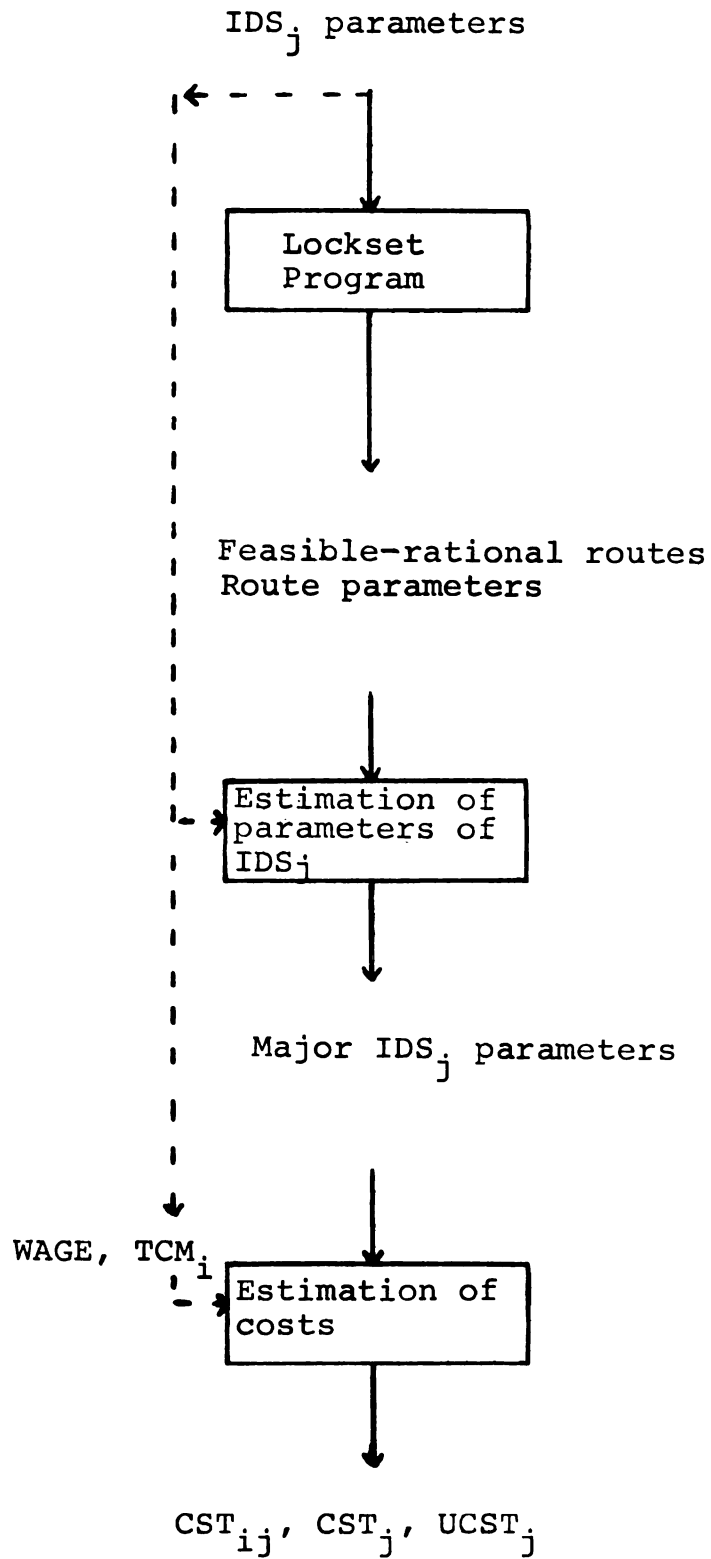


Figure IV-1. The intracity delivery method cost component.

ATT_{ij} = actual travel time in minutes in the i th route of IDS_j . This is produced directly by summing the travel time between all points in the route (including origin to first stop and from last stop to origin).

DIS_{ij} = total miles in the i th route of IDS_j . Obtained by summing distance between all points in the route.

Next, as indicated in Figure IV-1, the Lockset-determined variables and certain structural parameters are employed to estimate the major physical variables for IDS_j :

For IDS_j :

R_j = total routes in IDS_j .

$$R_j = \sum_{i=1}^n R_{ij} \times DEL_j. \quad \sum_{i=1}^n R_{ij} \text{ is the number of}$$

feasible-rational routes defined by Lockset analysis. To estimate total distribution costs for IDS_j , we must consider the number of times each route is run; in essence, if 2 routes are defined and $DEL_j = 3$, then there are 6 routes. If $DEL_j = 1$, then

$$\sum_{i=1}^n R_{ij} = R_j.$$

$$S_j = \text{total number of stops in } IDS_j. \quad S_j = \sum_{i=1}^n S_{ij} \times DEL_j.$$

TRT_{ij} = total route time converted to hours for the i th route in IDS_j .

$$TRT_{ij} = ATT_{ij} + TST_{ij} + DET; \text{ where } TRT_{ij} \leq MAT.$$

TRT_j = total route time in hours in IDS_j .

$$TRT_j = \sum_{i=1}^n TRT_{ij} \times DEL_j$$

$$DIS_j = \text{total miles in } IDS_j. \quad DIS_j = \sum_{i=1}^n DIS_{ij} \times DEL_j.$$

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Other parameters of interest:

TTT_j = total travel time converted to hours in IDS_j .

$$TTT_j = \sum_{i=1}^n ATT_{ij} \times DEL_j.$$

TST_j = total stop time converted to hours in IDS_j .

$$TST_j = \sum_{i=1}^n TST_{ij} \times DEL_j.$$

These parameters, along with certain structural parameters and parameters measuring labor and truck costs, are employed to estimate delivery cost for IDS_j via the following method (see Figure IV-1):

WAGE = hourly wage rate in dollars, including overhead for drivers.

TCM_i = truck operating cost per mile in dollars for TS_i , where $i = 1, 2$.

CST_{ij} = total cost in dollars of the i th route in IDS_j .
 $CST_{ij} = (TRT_{ij} \times WAGE) + (DIS_{ij} \times TCM_i).$

$UCST_{ij}$ = average total cost per case of the i th route.
 $UCST_{ij} = CST_{ij} / VOL_{ij}.$

CST_j = total cost in dollars of IDS_j .

$$CST_j = \sum_{i=1}^n CST_{ij} \times DEL_j.$$

$UCST_j$ = average total cost per case in IDS_j .
 $UCST_j = CST_j / VOL_j.$

Line-Haul, Warehouse, and Communications Cost Component

Line-haul costs are required when the origin in IDS_j is not the processing point. Then the origin is either a food chain's distribution center or a wholesale distributor's

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location. There is an intermediary firm in the channel; eggs must be transported in truckload lots from the processor to the intermediary firm. Line-haul parameters are:

LHC_{mn} = line-haul cost per case in dollars from origin m to destination n (which is $ORIGIN_1$) and return.

FLHC = fixed line-haul cost per case in dollars. This parameter is independent of distance and primarily is the cost of driver's labor in loading and unloading.

LHCCM = line-haul cost per case per mile in dollars; the cost of truck and driving labor as a function of distance.

DIS_{mn} = distance in miles between m and n and return.

The line-haul cost equation is:

$$LHC_{mn} = FLHC + (LHCCM \times DIS_{mn}).$$

Warehousing becomes a relevant activity when an intermediary firm, either a distribution center or wholesale distributor, are incorporated into a channel system. There is no direct delivery from the egg processing firm to retail stores. For both a food chain's distribution center and the wholesale-distributor, the same warehousing cost per case is assumed. The warehousing cost parameter is:

DWHC = per case cost in dollars of the warehousing activity performed either by a food chain distribution center or an egg wholesale-distributor.

There are five communications cost parameters (discussed in detail in the following chapter):

IPSC = independent egg processor's sales cost per case in dollars.

IDPC = independent wholesale distributor's purchase cost per case in dollars.

IDSC = independent wholesale distributor's sales cost per case in dollars.

CSPC = purchase cost per case in dollars for the food chain not integrated into processing.

CTRC = transfer cost per case in dollars for the integrated food chain.

In the next chapter, the wage rate, truck costs, line-haul cost, and communication costs are presented.

The Model

To reiterate, the model has two components--the intracity delivery cost component and the line-haul, warehousing, and communications cost component. From these two components, four costs or groups of costs can be brought into the general model to estimate a channel system cost. Which costs are relevant is dependent upon the type and structure of the channel system. These costs are: (1) intracity delivery cost, $UCST_j$, which is relevant to any channel system; (2) line-haul cost; (3) warehouse cost; and (4) communications cost.

Figure IV-2 indicates the framework of the model for estimating costs of alternative distribution channel systems. The volume of eggs required by the distribution channel system, VOL_j , can flow through a number of channels. The first variation is integrated or independent channel

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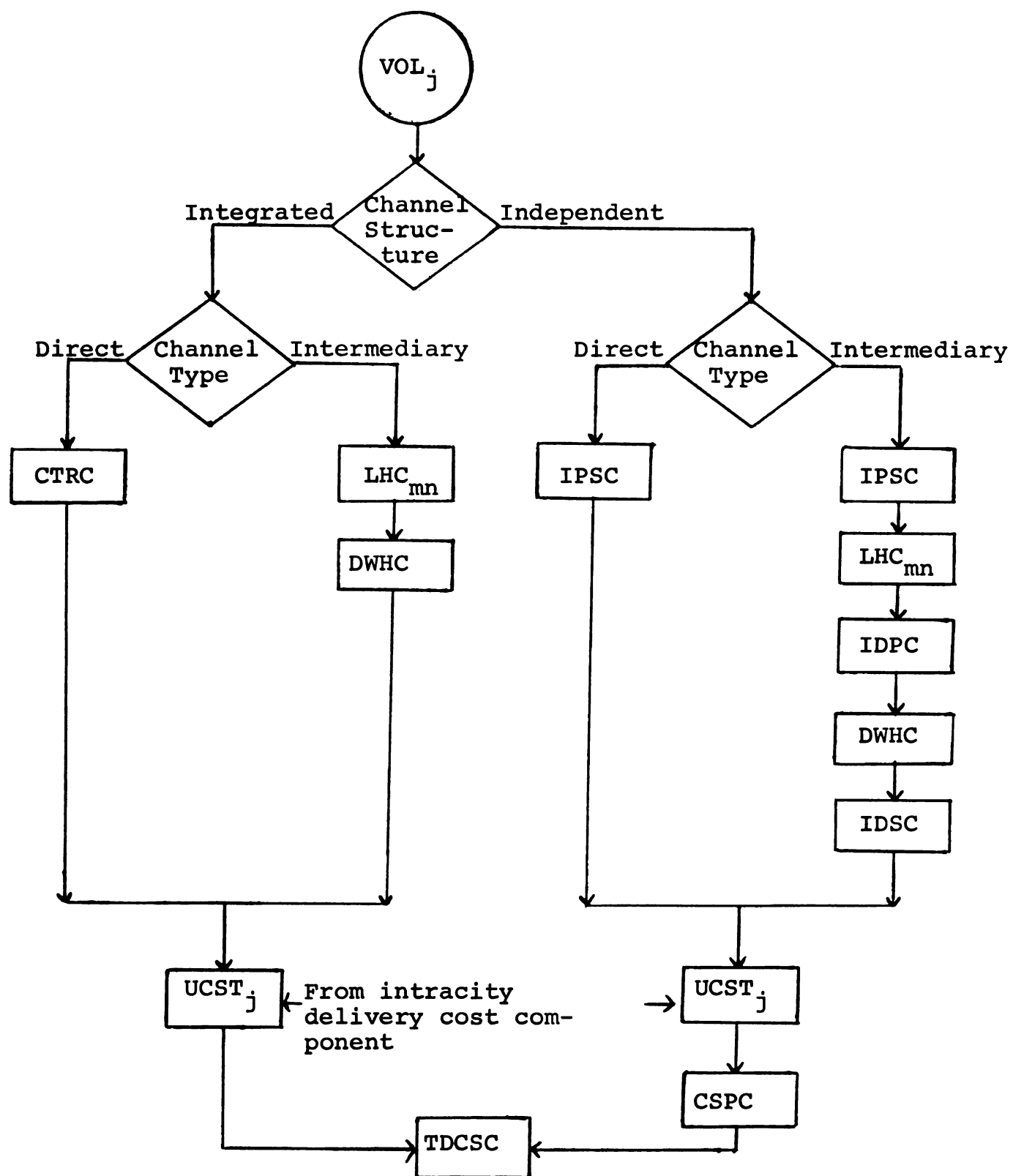


Figure IV-2. Conceptual framework of a model for estimating costs of alternative egg distribution channel systems.

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system structure. In either an integrated or independent structure, the second variation is direct versus intermediary channel types. Within the intermediary channel type, further variation is provided by the distance involved in line-haul cost estimation. This is a function of what origin is the shipping point. Although this is not explicitly shown in Figure IV-2, alternative processing points (shipping points) can be evaluated. The cost of the j th intracity delivery system is relevant regardless of the channel structure or type. In addition, in an independent channel structure, regardless of type, food chain purchase cost is relevant. The channel structure, type, and the method of intracity delivery determine the total distribution channel system cost, TDCSC, for the flow of VOL_j .

Conceptually, total distribution channel system cost per case in dollars, TDCSC, for a channel system is estimated as:

$$\begin{aligned} \text{TDCSC} = & \text{LHC}_{mn} + \text{DWHC} + \text{IPSC} + \text{IDPC} + \text{IDSC} + \text{CTRC} \\ & + \text{UCST}_j + \text{CSPC}. \end{aligned}$$

But in practical terms, a single channel system could not contain all these parameters. For example, if it is an independent channel, CTRC would not be included. Further, if the channel is also direct, LHC_{mn} , DWHC, IDPC, IDSC are not relevant. More explicitly, in this case:

$$\text{TDCSC} = \text{IPSC} + \text{UCST}_j + \text{CSPC},$$

where

IPSC = independent processor's sales cost per case in dollars;

UCST_j = truck and labor cost per case in dollars for direct delivery in IDS_j ;

CSPC = purchase cost per case in dollars for the food chain.

Complete specifications of all distribution channel systems in this analysis are in the next section.

Specifications

In this section, detailed specifications of alternative methods of intracity delivery and egg distribution channel systems are presented. First, attention is given to the integrated food chain's egg distribution system.

Integrated Food Chain's Egg Distribution System

The integrated food chain provided the bulk of all primary data utilized in this research. A goal of this analysis was to provide the firm with valid cost comparisons of alternative egg distribution channel systems with the firm's present system. This required considerable data and information which were provided by the firm. Specific data provided were store locations, store volume requirements, store stop times (estimated for direct delivery), intracompany transfer cost, and general operating practices.

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Basic data provided the specifications for intracity delivery methods.

The integrated food chain is of national scope. It owns and operates a number of egg processing plants in the United States. Eggs are procured from producers and then graded and cartoned in the plant for ultimate sale in the firm's retail food stores. In this study, the Michigan operations were analyzed.

The firm has a large number of stores in the Detroit SMA. A sample of seventy-two of these stores were included in the intracity distribution analysis. These represented most of the firm's stores in the Detroit SMA. The egg processing plant is approximately 110 miles from the firm's distribution center in a Detroit suburb. In the present system, cartoned eggs in cases are transported in 700-case lots (or larger) from the egg plant to the distribution center. There the eggs are unloaded, temporarily stored, then loaded with produce, bread, and dairy products (no milk) onto the tractor-trailers for distribution to retail stores. Deliveries to stores are made four times per week. From one to three stores are serviced by a trailer load of produce items.

Individual stores contact the distribution center indicating the egg requirement. In the distribution center, the egg merchandiser relays orders to the egg plant. Trailers are dispatched regularly from the distribution center to the

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plant. At the plant, the trailer is left, and the tractor returns with a trailer load of eggs. It is important to note that the egg plant serves as an interchange point for company trucks moving products in the firm's overall distribution system. This is an important element when considering alternatives to the present egg distribution system. The egg plant, distribution center, and individual stores are linked via an effective communications system.

Because of the possible effect of excessive handling and temporary storage upon egg quality, a tentative question is raised as to why the firm with control over its supplies does not implement direct deliveries from plant to stores. But in at least one other case where a food chain is integrated into egg processing, the same processing plant-distribution center-retail store method is followed.² Although this analysis will estimate the cost of direct distribution, it will later be shown that there are definite constraints upon direct delivery.

Intracity Delivery Methods

Seven methods of intracity delivery are analyzed. In Table IV-1 specifications of these are presented. A description of each delivery method follows.

²A second food chain of national scope indicated that this policy was followed even though in some areas it owned egg processing plants.

TABLE IV-1.--Specifications of alternative intracity delivery methods.

IDS	VOL _j	DEL _j	STORES	ORIGIN ^a _k	TS _i	MAT	DET
	(cases)			k=	(cases)	(minutes)	
IDS ₁	5400	3	72	1	700	720	45
IDS ₂	5400	3	72	1	300	720	45
IDS ₃	5400	3	72	2	700	840 ^b	45
IDS ₄	5400	3	72	2	300	840 ^b	45
IDS ₅	5400	3	72	2	700 ^c	720	45
IDS ₆ ^d	5400	3	72	2	700	720	45
IDS ₇ ^d	5400	3	72	2	300	720	45

^aORIGIN₁ = site of integrated food chain's distribution center within the Detroit SMA. ORIGIN₂ = site of integrated food chain's egg plant about 110 miles from the Detroit SMA.

^bIn both IDS₃ and IDS₄, MAT is set at fourteen hours.

^cIDS₅ is a variation of IDS₃ and IDS₄ where one set of drivers is assigned to driving trucks to and from the market area where they are taken through routes by different drivers.

^dIDS₆ and IDS₇ are variations of IDS₃ and IDS₄ respectively where MAT is set at 720 minutes. Routes must be run from ORIGIN₂ and return within 720 minutes instead of 840 minutes.

IDS₁ is delivery from ORIGIN₁, the location of the integrated food chain's distribution center, to stores via 700-case truck with MAT set at 720 minutes.

IDS₂ is delivery from ORIGIN₁ to stores via 300-case truck with MAT set at 720 minutes.

IDS₃ is delivery from ORIGIN₂, the integrated food chain's egg plant site, via 700-case truck to stores. Actual route time is set at 840 minutes.

IDS₄ is delivery from ORIGIN₂ via 300-case truck to stores. The same assumptions regarding MAT exist as for IDS₃.

IDS₅ is delivery from ORIGIN₂. An attempt is made to program routes so that one set of driver(s) transports eggs from ORIGIN₂ to the market area and another set runs the routes. Here an effort is made to reduce the number of trucks required in other ORIGIN₂ methods.

IDS₆ is delivery from ORIGIN₂ via 700-case truck. MAT is set at 720 minutes and routes are programmed so that a route originating at ORIGIN₂ must not require over 720 minutes (from ORIGIN₂ through route and return).

IDS₇ is delivery from ORIGIN₂ via 300-case truck with MAT set at 720 minutes as in IDS₆.

Differences among the delivery methods are found in truck size, origin, time allowed for a route (MAT), and assumptions regarding whether drivers run complete routes or specialize in transport from ORIGIN₂ to the market and return. This latter set of assumptions is referred to as

driver policy, DP. In Table IV-2 a matrix of primary factors (parameters) affecting specifications and costs among alternative delivery methods is presented.

Next are the identification and discussion of specific parameters of delivery methods.

VOL_j and WVOL_h. Total volume required by all stores in each distribution channel system, VOL_j, is the same for all IDS_j's, 5400 cases. This volume was estimated from data provided by the integrated food chain. Average weekly requirement per store was 75 cases. The range was 35 to 115 cases. In lieu of actual requirements for each store (STORES = 72), which were not made available, 10 per cent of the stores were randomly assigned the 35-case requirement and 10 per cent assigned the 115-case requirement. For the 72 stores, 8 had a 35-case demand, 8 a 115-case demand, and 56 the average demand, 75 cases. Weekly volume per store is the same in each IDS_j; that is, $WVOLS_{h1} = WVOLS_{h2} = \dots = WVOLS_{h7}$. For STORE_h, the hth store in an IDS_j where $h = 1, 2, \dots, 72$, there is a corresponding code number. In Appendix A, stores are identified and weekly volume indicated.

ORIGIN_k. $k = 1, 2$. ORIGIN₁ is the location of the integrated food chain's distribution center within the Detroit SMA. ORIGIN₂ is the location of the integrated food chain's egg processing plant, approximately 110 miles from ORIGIN₁. These two origins serve as shipping points in alternative intracity distribution systems.

TABLE IV-2.--Matrix of primary factors affecting specifications and costs among alternative methods of intracity and delivery.

IDS_j	IDS_1	IDS_2	IDS_3	IDS_4	IDS_5	IDS_6	IDS_7
IDS_1	--	TS	ORIGIN MAT	ORIGIN TS, MAT	ORIGIN TS, DP	ORIGIN	ORIGIN TS
IDS_2	TS	--	ORIGIN TS, MAT	ORIGIN MAT	ORIGIN TS, DP	ORIGIN TS	ORIGIN
IDS_3	ORIGIN MAT	ORIGIN TS, MAT	--	TS	TS, DP	MAT	TS, MAT
IDS_4	ORIGIN TS, MAT	ORIGIN MAT	TS	--	TS, DP	TS, MAT	MAT
IDS_5	ORIGIN TS, DP	ORIGIN TS, DP	TS, DP	TS, DP	--	TS, DP	TS, DP
IDS_6	ORIGIN	ORIGIN TS	MAT	TS, MAT	TS, DP	--	TS
IDS_7	ORIGIN TS	ORIGIN	TS, MAT	MAT	TS, DP	TS	--

Note: TS = truck size; ORIGIN = difference in shipping point; MAT = time constraints;
DP = driver policy.

MAT,DET. Time allowed for delivery in routes is important in affecting route configurations, route, and IDS_j costs. In IDS_1 and IDS_2 , IDS_6 , and IDS_7 , MAT was set at 720 minutes. This was the total time within which a route could be defined, including travel to the first stop and travel from the last stop to the origin. In IDS_3 and IDS_4 , time for actually running a route was set at 840 minutes. The 720-minute constraint was selected based on the assumption that, if possible, a driver would not exceed 40 hours per week. With three deliveries per week, a route with a maximum time of 12 hours would require a driver to operate less than 40 hours per week. But routes in excess of 720 minutes may result in some IDS_j 's where MAT is 840. It is important to note that firms utilizing the Lockset program must consider MAT, DET, and driver policy in planning distribution systems. DET was set at 45 minutes in each IDS_j .

STS_h. Stop time per store is the same in all IDS_j 's. Stop time per store was estimated from data provided by the integrated food chain. Stop time was estimated by the following equation:

$$STS_h = a + b_1 VOLS_h,$$

where

STS_h = stop time in minutes at the hth store;

a = time in minutes for positioning truck not related to volume delivered;

b_1 = actual unload time per case in minutes;

$VOLS_h$ = volume in cases delivered to the hth store.

The a value is constant among all stores. But the b_1 value is a function of volume delivered. Most egg deliveries are palletized and loaded-unloaded with a truck or hand fork-lift. Twenty-five cases are loaded on a single pallet. It is assumed that the driver gets some assistance at the store. Unload time per pallet is 6.10 minutes. Since deliveries to stores include 12-, 25-, and 38-case volumes, some adjustments have to be made for the 12- and 38-case delivery. In these, some manual handling is required since less than full pallet delivery is required in each. Total stop times for stores were:

<u>Cases delivered</u>	<u>a</u> (min)	<u>b_1</u> (min)	<u>STS_h</u> (min)
12	10.0	.55	16.0
25	10.0	.24	16.0
38	10.0	.33	23.0

In Appendix A stop time for each store is listed.

TS_i . Two sizes of trucks are considered, $i = 2$.

TS_1 is a 700-case refrigerated trailer. TS_2 is a 300-case refrigerated straight truck.

D, D' . D values are distances in miles, converted to minutes, between pairs of stores. These "key link" values are obtained by considering each store as a hub in a wheel. Then key links are defined by connecting the store to

surrounding stores which are likely to be in the same route. This method does not necessitate the consideration of all possible pairs of stores as key links. For the seventy-two stores, there are approximately 240 key links, D values. On a map of the Detroit SMA, each store was located. Then the key links were identified. A map wheel was used to determine the distance between two stores over likely routes in miles. D' values are distances in miles, converted to minutes, between the distribution center, $ORIGIN_1$, and each store. D' values were also obtained by the use of the map wheel. When $ORIGIN_2$ is the shipping point, five additional D' values are required instead of seventy-two. These additional D' values are for distances between $ORIGIN_2$ and each of five stores closest to the origin. These stores are those which would be first reached when delivery is from $ORIGIN_2$. The conversion of the mileage coefficients was done by the computer assuming an average speed of 25.0 mph. For some, key link conversions were done manually considering road type and congestion between two points. The additional five D' values were estimated considering a higher driving speed since the egg plant and these stores were connected by an interstate highway.

Distribution Channel Systems

Two structures of distribution channel systems are evaluated. One is integrated and the other is independent. Within each structure there are two channel types; one is

direct and the other is intermediary. A direct channel type, whether integrated or independent, involves delivery direct from the processing plant to retail stores. An intermediary channel requires delivery from a distribution center or wholesale-distributor to stores. For either shipping origin, a line-haul operation is required from the processing firm.

The basic distribution channel systems are:

1. INTDCS, integrated direct channel system.
2. INTICS, integrated intermediary channel system.
3. INDDCS, independent direct channel system.
4. INDICS, independent intermediary channel system.

The specifications and description of each channel system are presented next.

INTDCS. Integrated direct channel systems represent potential or synthetic channel systems of the integrated food chain. "Potential" implies that the firm could initiate the channel system. "Synthetic" implies that some characteristic of the channel makes it not a potential system for the firm but the channel approximates some channels which exist.

INDDCS₁ is a channel which incorporates either IDS₁ or IDS₂. That is, distribution is from ORIGIN₁ via 700-case truck or 300-case truck respectively. This is a synthetic channel system since it is assumed that the processing plant is at ORIGIN₁ within the market area.

INDDCS₂ is a channel which incorporates either IDS₃, IDS₄, IDS₅, IDS₆, or IDS₇. Distribution is from the processing plant at ORIGIN₂. This is a potential channel system since the integrated firm could initiate deliveries from this origin.

INTICS. Intermediary channels differ primarily from direct channels in that a line-haul is required from the processing origin to ORIGIN₁ from which distribution to stores is made.

INTICSP is the present channel system of the integrated food chain. Eggs are line-hauled from ORIGIN₂, the processing origin, to the distribution center, ORIGIN₁. Eggs are delivered to stores in mixed loads with produce items. Some variation is provided by assuming a different processing origin which requires different line-haul costs. Delivery costs are estimated from the Kearney study and not by the intracity delivery cost component.

INTICS₁ is a channel which utilizes either IDS₁ or IDS₂. Distribution is from the distribution center to stores. Eggs are delivered in single product loads, which is the difference from INTICSP. This channel requires line-haul from the egg plant at ORIGIN₂. This is a potential channel for the integrated firm. Variations are provided by assuming other processing origins.

In Table IV-3, specifications of distribution channel systems are presented.

INDDCS. Both independent channel types are synthetic channels in that they are similar to actual channels involving independent processors, wholesale-distributors, and food chains.

INDDCS₁ is a channel which utilizes either IDS₁ or IDS₂. Distribution is from a processing firm assumed located at ORIGIN₁. Delivery is direct from the processing firm to retail stores.

INDDCS₂ is a channel which utilizes either IDS₃, IDS₄, IDS₅, IDS₆, or IDS₇. Distribution is direct to stores from the processing firm at ORIGIN₂.

The basic difference between these direct systems and the integrated direct systems is how the channels are coordinated. In the former, the exchange process directs the flow of eggs through the channel. In the latter, the administrative process directs the flow of eggs within the boundaries of a single firm but through separate business units.

INDICS. The independent intermediary channel differs from the direct channel in that delivery is from a wholesale distributor located at ORIGIN₁.

INDICS₁ is an intermediary channel which utilizes either IDS₁ or IDS₂. Delivery is made from a

TABLE IV-3.--Specifications of distribution channel systems.

Specifications	Distribution Channel Systems						
	INTDCS1	INTDCS2	INTICSP	INTICS1	INDDCS1	INDDCS2	INDICS1
<u>Intracity Delivery Method</u>							
IDS 1	*			*	*		*
IDS 2	*		n.a.	*	*		*
IDS 3		*				*	
IDS 4		*				*	
IDS 5		*				*	
IDS 6		*				*	
IDS 7		*				*	
Processing origin	1	2		2	1	2	2
<u>Line-haul</u>							
Origin(s)			2	2			2
Sales cost, IPSC							
Transfer cost, CTRC	*	*	*	*	*	*	*
<u>Intermediary Cost</u>							
Distributor's purchase cost, IDPC							
Warehouse cost, DWHC			*	*			*
Distributor's sales cost, IDSC							*
Chain store purchase cost, CSPC					*	*	*

wholesale distributor at $ORIGIN_1$. Line-hauling is required from the processing origin, $ORIGIN_2$. Variations are provided by considering alternative processing origins.

Summary

In this chapter, the research procedure and methodology have been described in detail. The general model and its component parts were developed. Specifications of the integrated food chain's operations, intracity delivery methods, and distribution channel systems were discussed in detail.

In the next chapter, wage, line-haul, truck, warehousing, and communications costs are developed for channel firms.

CHAPTER V

COST ESTIMATES FOR FIRMS

The purpose of this chapter is to develop the wage, truck, line-haul, warehouse, and communications costs for firms in this analysis. For warehousing and communications costs, alternative estimates are presented and the explanation for the selected cost coefficients is given. This approach is followed in order to substantiate the selected cost coefficients as being in a valid range of coefficients derived from other sources.

Labor Cost

The labor cost is the hourly wage plus labor overhead paid to truck drivers. Other labor resources are accounted for in cost components such as warehouse operations.

The hourly wage often used in various research studies does not include the fringe benefits which are an outlay of the firm. Normally, the wage utilized is the basic hourly wage with adjustments for overtime. However, to provide realistic labor costs requires that labor overhead be incorporated into the base wage. This is an extremely important consideration because the labor expense

accounts for 40 to 60 per cent of distribution cost for a given delivery route. Underestimating the cost of labor in distribution can result in inefficiently structured distribution systems. The trend toward increased wages and unionized drivers emphasizes the need for efficient labor utilization.

In this study labor overhead was combined with the base wage to derive the hourly wage rate. Labor overhead includes pension and welfare, social security, unemployment compensation, workmen's compensation, and vacation. Two food chains indicated that labor overhead was approximately 25 per cent of the hourly base wage for truck drivers. Therefore, labor overhead was assumed to be 25 per cent of the base wage. Data concerning the base wage were obtained from the integrated food chain. The base wage was 4.17 dollars per hour. Table V-1 gives the hourly base wage, labor overhead, and the hourly wage rate for truck drivers used in this analysis.

TABLE V-1.--Hourly base wage, labor overhead, and hourly wage rate (WAGE) for truck drivers.

Item	Cost
Hourly base wage (dollars)	4.17
Labor overhead (25 per cent) (dollars)	<u>1.04</u>
Hourly wage rate (WAGE) (dollars)	5.21

Source: Data supplied by food chains.

Truck Costs

An egg handling firm has two alternatives for transporting eggs. One is private carriage where the egg handler either buys or leases vehicles and performs the transport function. The legal definition of private trucking is that the shipper is the bona fide owner of the goods [4, p. 128]. The second alternative is exempt for-hire motor carriers. For-hire motor carriers of certain agricultural commodities are exempt from economic regulation by the Interstate Commerce Commission over routes and rates. Exempt for-hire trucking firms depend entirely on hauling agricultural commodities. Hunter [15, p. 4] noted that,

Exempt for-hire trucking firms compete in an open market with one another and with other types of carriers in securing loads to haul. Rates are negotiable between the trucking firms and the shipper or receiver, depending on whether the shipment is FOB origin or destination.

Truck brokers of exempt agricultural commodities sometimes publish suggested rates which are often used. But the level of transport rates among alternative egg handlers and their truckers can be quite varied. The costs of operating private trucking operations are not well known by most egg handlers.

Due to the variability of transport rates and the unavailability of transportation costs from firms in this analysis, truck costs are developed from two previous studies [20, 11]. Truck cost data in these studies were adjusted for this analysis.

Two sizes of vehicles are considered. One is a 40-foot refrigerated trailer with a capacity of 700 cases of eggs. The other is a refrigerated straight truck with a capacity of 300 cases. Variable and fixed operating costs, excluding labor, are developed for each.

Trailer Operating Cost

Basic data for refrigerated trailer operating costs were adapted from a USDA study of bulk and packaged milk transport costs [20]. A 40-foot refrigerated trailer used for packaged milk transport is similar to vehicles used in egg distribution. Larger capacity vehicles are in use, but this vehicle is more common at present.

To determine fixed operating costs for 1969-70, data from the USDA study were inflated. In Appendix B, Tables 1 and 2 indicate how fixed operating costs are derived.

Variable operating costs and method of estimating are presented in Appendix B, Table 3. It is noted that driver wages are not included in this formulation. Wages enter into line-haul costs and intracity delivery cost.

Table V-2 presents fixed, variable, and total operating cost per mile for both the 40-foot trailer and straight truck.

Straight Truck Operating Cost

Basic data were adapted from a study of the optimum location of egg processing plants in Indiana [11].

In Appendix B, Tables 4 and 5 indicate how fixed operating costs were derived. Some adjustments in the data were made. Variable operating costs and method of estimating are presented in Appendix B, Table 6.

Table V-2 indicates that the total per-mile operating cost for the refrigerated trailer is .3068 dollar and for the refrigerated truck .2070 dollar.

TABLE V-2.--Operating cost per mile, refrigerated tractor trailer and straight truck.

Cost	Cost Per Mile	
	Trailer (TCM ₁)	Truck (TCM ₂)
	(dollars)	
Variable (excluding labor)	.1305	.1410
Fixed	<u>.1763</u>	<u>.0660</u>
Total	.3068 ^a	.2070 ^a

^aAt same level of total annual mileage.

Source: See Appendix B.

Line-Haul Costs

Line-haul cost is the cost of moving a trailer-load of eggs, 700 cases, from an origin to a single destination. Relative to delivery to a multiple number of stops as in intracity distribution, the per-case cost of line-haul movement even for greater distances can be less. Single

origin-single destination movement of large quantities is the most operationally efficient egg distribution transit operation.

The major components of line-haul costs are labor and truck. In addition to driver's actual driving time, time spent loading at origin and unloading at destination is included in line-haul cost. In line-haul operations all equipment operated in one direction must eventually make a return move in the opposite direction, thus making available the same line-haul transportation weight and space capacity on the return movement of the vehicle. For this reason the round-trip expenses have the nature of a joint cost and consideration must be given to apportioning round-trip costs among all traffic transported on the round trip [16, p. 17]. Therefore, if there is no back haul, total round-trip costs must be allocated to the single load of product. In this study, no back haul is assumed and all the round-trip cost (origin to destination) is borne by the origin-to-destination quantity of eggs.

Line-haul costs are developed only for the 700-case trailer since smaller vehicles are seldom involved in line-haul operations.

The line-haul cost equation is derived by the following method:

$$(1) \text{ total line-haul cost} = a + bD_{mn},$$

where

a = the fixed labor cost in dollars, independent of distance, of loading and unloading the trailer;

b = total operating cost per mile in dollars, including driver's wages, of the tractor-trailer;

D_{mn} = the distance in miles from origin m to destination n and return.

The fixed labor cost, a , was estimated from data measuring actual loading and unloading time. The integrated food chain indicated that for palletized handling, load and unload time were one hour each. At the hourly wage rate of 5.21 dollars, fixed labor cost, a , is 10.42 dollars. This assumes that the driver is either involved directly in loading and unloading or is required to be idle until each activity is completed. In either case, there is involved a cost. Total operating cost per mile, b , is obtained by summing operating cost per mile exclusive of labor and the driver's labor cost per mile. Driver's labor cost per mile was derived by dividing the hourly wage rate, 5.21 dollars, by the estimated line-haul driving speed of 40.0 miles per hour. Line-haul driving speed has a direct effect on driver's labor cost per mile. Now equation (1) becomes:

$$(2) \text{ total line-haul cost} = 10.42 + .4344 D_{mn} \text{ in dollars.}$$

In the previous chapter, line-haul cost per case from origin m to destination n was defined as:

$$(3) \quad LHC_{mn} = FXLHC + (LHCCM \times D_{mn}),$$

where

LHC_{mn} = line-haul cost per case in dollars from origin m to destination n and return;

$FXLHC$ = fixed line-haul cost per case in dollars;

$LHCCM$ = total operating cost per case per mile in dollars;

D_{mn} = distance in miles from origin m to destination n and return.

Dividing the coefficients, a and b , in equation (2) by 700 cases gives the following values for equation (3):

$$(3) \quad LHC_{mn} = .0150 + .0007 D_{mn},$$

where

$FXLHC = .0150$ dollar,

$LHCCM = .0007$ dollar.

This equation is used to estimate line-haul costs from an origin m to a destination n . In Table V-3 line-haul costs per case for alternative distances are presented.

TABLE V-3.--Line-haul cost per case of eggs, alternative distances.

D_{mn}^a		LHC_{mn}
(miles)		(dollars per case)
112	Origin ₂ to Origin ₁	.1718
200	Origin ₃ to Origin ₁	.2950
250	Origin ₄ to Origin ₁	.3650

^aOne way distance.

Warehousing Cost

Because two types of warehousing operations are included in this study--an egg wholesale distributor and a food chain's distribution center--a question arises as to whether the warehousing cost per case is the same for each. A priori, since the wholesale distributor is specializing in eggs, it would seem that given comparable mechanization in materials handling, the wholesale distributor could operate at the same or lower cost per case than the distribution center. In the warehousing activity or order selection, the wholesale distributor would likely be more operationally efficient (single versus multi-product warehouse). However, as noted in Chapter IV, it is assumed that the warehousing cost, DWHC, is the same for both types of operations.

Table V-4 presents five alternative estimates of warehousing costs for eggs--including the cost assumed, DWHC. The Kearney [19] study derived receiving, transfer, order selection, and shipping costs per case of lettuce. Because of similar weight and perishability properties, this coefficient, .1150 dollar per case, can be considered a proxy value for eggs. The Yergatian and Storey [40] study provided data from which a warehousing cost per case, .1081 dollar, for an egg wholesaler was derived (see Table III-1). Another estimate of a food chain's warehousing cost

TABLE V-4.--Alternative estimates of egg warehousing costs per case.

Estimate	Cost per Case
	(dollars)
(1) Cost assumed in this analysis, <u>DWHC</u>	.1150
(2) Kearney study, food distribution center	.1150
(3) Yergatian and Storey, egg wholesalers	.1081
(4) Food chain warehousing as percentage of sales method	.1221
(5) Detroit egg wholesaler distributor	.1000

Source: See accompanying text.

was derived by using the cost of warehouse operations as a percentage of sales for large food chains (over 100 million dollars sales annually). The Standard Manual of

Accounts of Food Chains defines the responsibility center of warehouse operations:

The expenses of this responsibility center include all of the costs (excluding employee benefits and occupancy) of receiving, checking, storing, selecting, and loading of merchandise and supplies for distribution to stores. It should not include the cost of manufacturing, processing, or packaging operations located in the warehouse, which should be charged (directly or by credit to this center) to inventory [6, p. 70].

Table V-5 indicates how this coefficient, .1221 dollar per case, was derived and also presents transportation and merchandise-buying coefficients estimated in the same manner. An egg wholesale distributor in Detroit provided an estimate of .1000 dollar per case.

TABLE V-5.--Cost per case of eggs of specific food chain store responsibility centers.

Responsibility Center	Percentage of Sales ^a	Cost Per Case ^b
	(per cent)	(dollars)
Warehouse operations	.82	.1221
Transportation	.77	.1147
Merchandise and buying	.23	.0343

^aFor food chains with over 100 million dollars sales annually.

^bRetail sale value of 14.90 dollars per 24-dozen case of Grade A Large cartoned eggs. Estimated by using the United States average 1969 price for Grade A Large eggs in retail stores in urban areas, .6210 dollar per dozen.

Source: Earl Brown and Robert Day, Operating Results of Food Chains, 1968-69 (Ithaca, N.Y.: Cornell University, 1970), p. 30.

The estimate provided by the Kearney study is used in this analysis. This coefficient is utilized because of the more rigorous nature of the Kearney study and this coefficient is in an intermediate range of other alternative estimates. Warehousing cost, DWHC, is .1150 dollar per case.

Communications Cost

In Chapter V, the communications cost--egg processor's sales cost, wholesale distributor's sales cost, wholesale distributor's purchase cost, chain store purchase cost, and an integrated food chain's intracompany transfer cost were defined. Here the coefficients for each of these costs will be identified.

Processor's and Wholesale Distributor's Sales Costs

In Table V-6, some alternative estimates of large-scale processor's and wholesale distributor's sales costs are presented.¹ The primary differences among these estimates are the amount of fixed overhead allocated to sales costs in addition to management and office costs. Estimate (1) allocates overhead to sales but the amount of overhead is much lower for the wholesale distributor than for the egg processor in estimate (2). Both have the same annual

¹In the Yergatian and Storey study annual capacity is 374,000 cases. In the Peeler and King study annual capacity is 270,000 cases.

capacity. Estimate (3) includes no overhead and has a larger expenditure for management and office costs.

TABLE V-6.--Alternative estimates of sales costs for egg firms.

Estimate	Cost per Case
	(dollars)
(1) Yergatian and Storey, wholesale distributor	.0658
(2) Yergatian and Storey, egg processor	.0818
(3) Peeler and King, egg processor	.0725

Source: See Tables III-1, III-2, and III-3, respectively.

In this analysis, considering the problems inherent in estimating communications costs (see Chapter III), the coefficients derived from the Yergatian and Storey study will be used. Sales costs to individual stores which are not a part of a chain are not considered. More explicitly, the sales cost for an egg processor, IPSC, is .0818 dollar per case. The sales cost for the wholesale distributor, IDSC, is .0700 dollar per case. This study is utilized because some overhead costs are allocated to sales and purchase costs. In addition, both processor's and whole-sale distributor's operations are evaluated in this study. There is consistency among estimates for both firm types.

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Wholesale Distributor's and
Chain Store Purchase Costs

Purchase cost per case for a wholesale-distributor was estimated from the Yergatian and Storey study. This purchase cost, IDPC, is estimated at .0425 dollars per case (Table III-1).

For a food chain purchasing eggs from independent suppliers, the purchase cost was not made available from firms surveyed.² Purchase cost is not what the firm paid for eggs but rather the expenses associated with negotiating with suppliers for eggs. In Table V-7, estimates of chain store purchase costs for eggs are presented based on purchase cost as alternative percentages of gross sales. It is noted that the range in purchase cost is from .0298 to .1490 dollar per case. Based on the expenses allocated to the merchandise and buying center for large food chains (.23 per cent of sales, Table V-7) the purchase cost estimate is .0343 dollar per case. The merchandise and buying center is defined:

The expenses of this responsibility center include all costs (excluding employee benefits and occupancy) of the developing of merchandising and pricing policies and the procurement of all items sold or consumed in the stores. Include all buyers, merchandising managers, and clerical and administrative assistants [6].

²(Informally surveyed.) This type of information regarding costs is often closely guarded, although the integrated food chain provided close cooperation and willingly provided data, particularly on costs of intra-company transfer.

TABLE V-7.--Chain store purchase cost per case of eggs--
alternative costs.^a

Cost	Chain Purchase Cost as Percentage of Sales: ^b						
	.20	.23 ^c	.30	.50	.82 ^d	.90	1.00
(dollars)							
Purchase cost per case	.0298	.0343	.0447	.0745	.1224	.1341	.1490

^aThe cost of purchasing eggs from suppliers.

^bRetail sales value of 14.90 dollars per case.

^cMerchandise and buying center cost for large chains. See Table V-4.

^dIntracompany transfer cost for integrated food chain with an owned egg processing plant. The cost of coordinating egg flow from plant to distribution center to retail stores.

It is noted that the integrated food chain had an intra-company transfer cost of .82 per cent of sales or .1224 dollar per case. The integrated food chain is expected to have a higher communications cost as a percentage of sales since it includes expenses of the egg plant manager and his staff in addition to costs associated with the merchandising and buying center. For the independent food chain the purchase cost is assumed to be .30 per cent of sales. This assumes that some additional expense beyond the egg buyer-merchandising expense represented by .23 per cent of sales is necessary to get eggs into a store. For example, there is some cost of communications between

stores and the egg buyer. (This is reflected in the intra-company cost.) Therefore, the purchase cost, CSPC, is .0447 dollar per case.

Intracompany Transfer Cost

As noted in the preceding section, intracompany transfer cost for the food chain integrated into egg processing is .82 per cent of sales. This transfer cost, CTRC, is .1224 dollar per case.³

Presentation of Costs

In Table V-8, cost coefficients and/or equations are summarized.

³This cost includes a pro rata share of the salaries and travel expense of the dairy store contact man and the egg plant manager and his staff who contact the grocery merchandiser in the retail division and telephone expense. This information was supplied by a cooperating food chain.

TABLE V-8.--Cost coefficients and equations employed in the estimation of costs among alternative distribution channel systems.

Cost Description	Identification	Coefficient
		(dollars)
(1) Hourly wage rate	WAGE	5.21
(2) Truck cost per mile		
(a) tractor-trailer	TCM_1	.3068
(b) truck	TCM_2	.2070
(3) Line-haul cost per case	$LHC_{mn} = .0150 + .0007 D_{mn}$	
	(D_{mn} = distance between origin m and destination n and return)	
(4) Sales cost per case		
(a) egg processor	IPSC	.0818
(b) wholesale distributor	IDSC	.0700
(5) Purchase cost per case		
(a) wholesale distributor	IDPC	.0425
(b) chain store	CSPC	.0447
(6) Intracompany transfer cost	CTRC	.1224
(7) Warehousing cost per case		
(a) wholesale distributor	DWHC	.1150
(b) food chain distribution center	DWHC	.1150

CHAPTER VI

ANALYSIS OF COSTS OF ALTERNATIVE
DISTRIBUTION CHANNEL SYSTEMS

In this chapter the analysis of distribution channel systems as outlined in Chapter IV is made. The order of presentation is: (1) cost of the integrated firm's present system; (2) costs of alternative methods of intracity delivery; (3) costs of alternative channels for the integrated firm; (4) costs of synthetic channel systems; (5) effect of volume on channel system costs; (6) bargaining power and channel systems; and (7) costs of smaller, less coordinated channels.

Cost of Integrated Firm's Present System

INTICSP is the integrated food chain's present channel system. In the system eggs are line-hauled from the plant to the distribution center.¹ Eggs are delivered

¹Eggs generally are kept not more than one day in the distribution center. Normal inventory of eggs in the distribution center is about 200 cases on any given day. At times more eggs than required are shipped to the warehouse. This "shipping ahead" does not entail any significant inventory accumulation. Under normal conditions eggs do not remain in storage in a retail store for any length of time. Eggs received during the night are sold usually the following day. This is particularly true for the latter part of the week.

to stores in mixed loads with produce items. Eggs constitute from 10 to 15 per cent of a mixed load. Deliveries to one to three stores are made in one load. A large part of deliveries is to single stores and if only one store is in a route then the trailer is left to be unloaded by store personnel. If more than one store is serviced by a single load then deliveries to all stores except the last one are made. The driver normally returns to the distribution center with a trailer--picked up where the mixed load trailer was dropped--containing salvage items, boxes, etc. Approximately 40 per cent of all deliveries are unloaded by the driver (usually with assistance from store personnel) and the remaining 60 per cent are spotted (unloaded by store personnel).

Deliveries in this system are made between 7 p.m. and 7 a.m. This practice is somewhat different considering that many food chains and suppliers do not want drivers traveling in some urban areas at night because of the possibility of theft. Food chains often do not want drivers for independent suppliers to have access to stores when no store personnel are around. For these chains day delivery is more often undertaken. For the integrated firm, part of the problem is reduced since drivers are employees and may not have access to stores when trailers are spotted.

Because of the mixed commodities in a load, the delivery practices, and types of routes in this system, it is difficult to estimate costs of intracity delivery. Cost

estimates were not available from the firm. However, two valid cost coefficients were derived. The Kearney [19] study reported a distribution cost of .1350 dollar per case of lettuce from a distribution center to retail stores within 15-25 miles. A check on this coefficient was made by using the approach noted in Chapter V, where responsibility center costs for large food chains were derived. A transportation cost for eggs of .1147 dollar per case was estimated. Using an intermediate value, the cost of intracity delivery is assumed to be .1200 dollar per case. The average cost per case in this channel is .5292 dollar (Table VI-1).

TABLE VI-1.--Costs of INTICSP.

Cost Item	Cost per Case
	(dollars)
Line-haul cost, LHC_{mn} (112 miles)	.1718 ^a
Warehouse cost, DWHC	.1150
Intracity delivery cost	.1200
Transfer cost, CTRC	<u>.1224</u>
Channel cost	.5292

^aThe firm reported that the retail division is charged .008 dollar per dozen for the transportation of eggs to the distribution center. This line-haul cost developed independently is quite close to the firm's transportation charge.

Egg Distribution in the Total Distribution System

In the firm's overall distribution system five types of deliveries are made from the distribution center to retail stores. These are: (1) meat (straight truck); (2) groceries (trailer); (3) frozen foods (straight truck); (4) milk (trailer); and (5) produce (trailer). For any given store five different types of deliveries are made. The egg distribution system is an integral part of the firm's total distribution system centering on the distribution warehouse. Because of the scale of operation and the number of different kinds of deliveries made to stores a large number of drivers and trucks are utilized. The firm reported a major problem of getting drivers to perform to satisfactory standards. A plan to reduce drivers' workloads by consolidating more products into single loads (reduce the different kinds of deliveries made) for spotting at stores is being evaluated and considered. This plan tends to lessen the possible initiation of direct egg delivery even though faster delivery and less handling would result. But some important advantages of direct egg delivery do exist.²

²The firm reported problems due to excessive handling and time requirement on egg quality. However, no precise quantitative evaluation of the problem has been made. But the negative effect of time and handling on egg quality in channels has been analyzed. H. E. Larzelere, Changes in Egg Quality from Farm to Retail Store, A.E.S., M.S.U., Special Bulletin 400 (East Lansing, Mich: Michigan State University, 1955).

Alternative Intracity Delivery Methods

In this section the factors affecting costs among alternative methods of intracity delivery--from the integrated firm's distribution warehouse ($ORIGIN_1$) and its egg processing plant ($ORIGIN_2$) to retail stores--are examined relative to truck size, drivers required, time constraints upon drivers, and investment costs. This analysis is broadened to examine the effect of alternative methods of intracity delivery on other firms. The Lockset method of sequential programming [40] was used to define optimal route configurations for alternative methods.

Alternative Delivery Methods

IDS₁. This method is delivery to stores from $ORIGIN_1$ in 700-case trucks. Time is set at 720 minutes. Four routes were defined by the Lockset analysis. Two trucks and four drivers are required. Deliveries are made to thirty-two stores in two routes on Monday, Wednesday, Friday (MWF) in trucks A and B. Forty stores are serviced in two routes on Tuesday, Thursday, Saturday (TTS) by the same trucks. The total number of routes is twelve (Table VI-2). Stop time, which is the same in all systems, is 60.6 hours. It is greater than travel time due to the proximity of $ORIGIN_1$ to stores. Average cost per case is .1767 dollar. There is excess capacity in the system.³

³Excess capacity for an intracity delivery system is defined as the number of stores which could be included

TABLE VI-2.--Data for intracity delivery methods.

Item	Intracity Delivery Method						
	IDS ₁	IDS ₂	IDS ₃	IDS ₄	IDS ₅	IDS ₆	IDS ₇
<u>IDS_j Parameters</u>							
Number of routes, R _j	12	24	15	21	12	21	21
Total stop time, TST (hours)	60.6	60.6	60.6	60.6	60.6	60.6	60.6
Total travel time, TTT _j (hours) ^a	43.4	57.1	119.8	152.2	53.4	153.3	158.5
Total route time, TRT _j (hours) ^a	113.0	126.8	191.5	228.3	122.8	229.5	235.6
Distance, DIS _j (miles) ^a	1190	1680	4641	6035	1566	6054	6205
Excess capacity (stores)	24	5	10	10	12	12	0
<u>IDS_j Costs</u>							
CST _j (total dollars) ^a	954.00	1006.0	2421.0	2433.0	--	3082.0	2507.0
UCST _j (average dollars per j case)	.1767	.1863	.4483	.4515	.3950	.5705	.4643

^aRounded to nearest 10th of an hour, to the nearest mile, and to the nearest dollar, respectively.

Average truck utilization is 64 per cent and on the average 79 per cent of the time constraint (MAT) is used in each route. Twenty-four additional stores could be incorporated without new trucks or drivers. The geographic location of potential new stores would affect the level of excess capacity.

IDS₂. In this method 300-case trucks are used in delivery from ORIGIN₁ with MAT = 720 minutes. Eight routes were defined by the Lockset analysis. Four drivers and two trucks are required. On MWF deliveries are made to thirty-eight stores in four routes utilizing driver 1-truck A and driver 2-truck B. Each driver runs two routes on a given day. Upon completion of the first route a driver returns to ORIGIN₁, and the truck is loaded. Then the second route is begun. On TTS thirty-four stores are delivered to in four routes utilizing driver 3-truck A and driver 4-truck B. There are twenty-four routes in the system. As in IDS₁ travel time is less than stop time. Average cost is .1863 dollar (Table VI-2). There is little excess capacity (5 stores) since about 90 per cent of MAT is used in the routes. For each route set there is sufficient time for reloading

in the system without requiring new investment in trucks or hiring additional drivers. Since a major objective of the Lockset program is the minimization of the number of trucks (and drivers) required, any excess capacity which may result is unavoidable within the given specifications of intracity delivery. The flexibility for adding marginal changes in stores is important for a firm but excess capacity is not a goal of the present analysis.

but it is assumed that the driver is not involved. Loading time was set at forty-five minutes. If this time were added to route times for each route set, then on the average over 95 per cent of MAT would be used. The time spent in reloading reduces the potential for adding new stores within the time constraint.

IDS₃. In this method eggs are delivered in 700-case trucks from ORIGIN₂ with a time constraint of 840 minutes. The Lockset analysis defined five routes. Five trucks are required as are five drivers. Three routes are run on MWF to thirty-nine stores in trucks A, B, and C. On TTS two routes (trucks A and B) are run for delivery to thirty-three stores. Truck C is available on TTS for other uses--either delivery or assembly. Fifteen routes are run in a week. In contrast to preceding methods, travel time is about twice as large as stop time due to the greater distance of ORIGIN₂ from stores. Relative to these total distance is three to four times greater. Average cost is .4483 dollar. Average truck utilization is 50 per cent but an average of 91 per cent of the time allowance is used. In one route, however, only 18 per cent of truck capacity is needed and 59 per cent of MAT is required. The estimated excess capacity is ten stores.

IDS₄. Eggs are delivered from ORIGIN₂ in 300-case trucks with MAT = 840 minutes. Seven routes defined by Lockset analysis require four trucks and seven drivers.

Four routes are run on MWF to forty-five stores using trucks A, B, C, and D. On TTS, three routes--using trucks A, B, and C--are run to twenty-seven stores. Truck D is unused in this system on TTS. Twenty-one routes are required. Like IDS_3 , travel time is considerably larger than stop time. Average cost is .4515 dollar. In the system most routes utilized 90-100 per cent of truck capacity. But one route included only two stores and used 17 per cent of truck space and 40 per cent of MAT. Excess capacity for the system is ten stores.

IDS_5 . Eggs are delivered from $ORIGIN_2$ by 700-case trucks. One set of drivers shuttles trucks from the plant to designated stores in the Ann Arbor area, where they are left. The drivers return empty trucks to the plant. A second set of drivers takes the trucks through defined routes and returns them to the store where picked up or a store in close proximity. Four routes defined by the Lockset analysis require four drivers. Two routes are run to thirty-eight stores on MWF in trucks A and B. On TTS two routes (34 stores) are run in trucks A and B. Unlike other systems from $ORIGIN_2$, one-two drivers shuttle trucks to assigned stores in the Ann Arbor area and four drivers deliver in the defined routes; drivers do not run routes from $ORIGIN_2$ and return. Twelve routes are required. Exclusively for routes from where trucks are picked up to where they are returned, travel time is less than stop

time. Average route cost is .2074 dollar. The average cost of shuttling trucks from the plant to stores and return is .1876 dollar (which approximates line-haul cost from $ORIGIN_2$ to $ORIGIN_1$, but this is not exactly the same type of operation). Average cost is .3950 dollar. In the routes, time used averages 85 per cent. Excess capacity is estimated at twelve stores.

IDS₆. In this method 700-case trucks are used with $MAT = 720$. Seven routes were defined by the Lockset analysis. Four trucks and seven drivers are needed. On MWF four routes (44 stores) are run in trucks A, B, C, and D. On TTS three routes (28 stores) are run in trucks A, B, and C. Truck D is unused on TTS. There are twenty-one routes. Average cost is .5705 dollar. There is excess capacity of twelve stores. This was derived from one of the TTS routes in which only one store was served by a truck.

IDS₇. In this method 300-case trucks are used with $MAT = 720$. The difference between this system and IDS_4 is the smaller time allowance. Seven routes were defined by the Lockset analysis. Four trucks and seven drivers are necessary. On MWF four routes (47 stores) are run in trucks A, B, C, and D. On TTS three routes (35 stores) are run in trucks A, B, and C. Truck D is available on TTS for other uses. There are twenty-one routes required. Travel time is considerably greater than stop

time. Average cost is .4643 dollar. In most routes either 100 per cent of truck capacity or 100 per cent of time allowance is used. As a result there is little excess capacity.

ORIGIN₁ Methods

IDS₁ and IDS₂ have ORIGIN₁ as the shipping point. Each has a 720 MAT. For both the average cost is about the same (Table VI-3). More routes and more miles are in IDS₂ as would be expected since smaller capacity trucks are used. The same number of drivers (4) and trucks (2) are needed in each. More excess capacity is in IDS₁ primarily because of the larger trucks being under-utilized.

The criterion of average cost is not sufficient to make one method preferable over the other. For a firm an important consideration is the investment cost ratio. This is the ratio of the total investment required for 700-case trucks to the total investment needed to purchase 300-case trucks. A 3.84 greater investment in trucks is required in IDS₁. In addition the smaller trucks have a greater potential for use in assembly if needed.

ORIGIN₂ Methods

Five methods have ORIGIN₂ as their shipping point:

(1) IDS₃ (700-case trucks, 840 minutes); (2) IDS₄ (300-case trucks, 840 minutes); (3) IDS₅ (700-case trucks, two sets of drivers); (4) IDS₆ (700-case trucks, 720 minutes); and (5) IDS₇ (300-case trucks, 720 minutes).

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TABLE VI-3.--Costs, driver and truck requirements, and investment cost ratios for intracity delivery methods.

Intracity Delivery Method	Average Cost UCST _j	Requirements:			Investment Cost Ratio ^a
		Drivers	Trucks		
			700	300	
(dollars)					
IDS ₁	.1778	4	2	-	3.84
IDS ₂	.1863	4	-	2	
IDS ₃	.4483	5	3	-	2.88
IDS ₄	.4515	7	-	4	
IDS ₅	.3950	5-6	2	-	3.84
IDS ₆	.5705	7	4	-	
IDS ₇	.4643	7	-	4	

^aThis is the ratio of the total investment required for 700-case trucks to the total investment needed to purchase 300-case trucks between two methods with the same origin. See Appendix B for investment costs of new vehicles.

For IDS₃ and IDS₄ average cost is approximately the same (Table VI-3). In IDS₃ three 700-case trucks and five drivers are required. Four 300-case trucks and seven drivers are needed in IDS₄. Because of fewer routes and larger trucks the former method has fewer miles traveled. Each has the same excess capacity. As between IDS₁ and IDS₂ the choice of which method for a firm to adopt cannot

be based on the average cost criterion. The investment cost ratio is 2.88 which indicates that IDS_4 can be initiated with lower capital investment. If assembly is a function of the firm, then IDS_4 would provide some flexibility for trucks to be used in this activity. One truck would be available for use on TTS in either system if a driver is available. IDS_4 requires two more drivers; if labor is scarce, then this additional manpower (relative to IDS_3) might place the firm in a decision-making situation where greater capital investment is substituted for labor. For a firm the trade-off between larger capital investment and the acquisition of qualified drivers would have to be evaluated. If the firm faces a capital investment limitation, then IDS_4 is a more feasible method.

IDS_6 and IDS_7 have a 720-minute time constraint as compared to 840 minutes for the two preceding methods. In each method seven drivers and four trucks are required. The average cost of IDS_7 (.4643 dollar) is considerably less than for IDS_6 (.5705 dollar). Unlike the other two pairs of methods having the same origin, the cost difference between the 700-case truck method and the 300-case truck method is quite large. The higher relative average cost of IDS_6 is primarily explained by the underutilization of large trucks (in most routes less than 50 per cent of truck capacity was used). The time constraint restricted more stores and larger volume from being

incorporated into IDS_6 . The effect of the lower time constraint between IDS_3 and IDS_6 is evident by the greater requirement for trucks and drivers in IDS_6 (Table VI-3). Of the two methods with 720-minute constraints, IDS_7 has both a cost and a capital investment advantage. And no difference in labor requirement exists, which would create a need for a choice between capital investment and acquisition of drivers.

A look at IDS_4 and IDS_7 indicates that the reduced time constraint had little effect on average cost and no effect on truck and labor needs. In effect with $MAT = 720$, the Lockset analysis restructured routes so as to utilize the excess capacity of IDS_4 . The result is IDS_7 , which has little excess capacity. The difference in cost and resource requirements between IDS_3 and IDS_6 was noted. Reduction of MAT caused considerable changes in IDS_6 . This analysis indicates that if time restriction on drivers is twelve hours (or less) then 300-case trucks are more preferable.

Of the methods from $ORIGIN_2$, IDS_5 is the lower cost. Relative to other 700-case truck methods, it requires the same or fewer number of trucks and drivers. Compared to the 300-case truck methods, the investment cost ratio is 1.9. But one-two fewer drivers are needed. If labor is difficult to obtain at $ORIGIN_2$ this method permits more drivers to reside in the urban area closer to $ORIGIN_1$.

This aspect might lessen the problem of obtaining drivers. IDS_5 is slightly more complex since it requires drivers to pick up loaded trucks at designated stores instead of drivers running routes from the plant and returning. In IDS_5 there is no flexibility for using the two trucks in assembly.

Effect of Distance on Intracity Delivery Costs

The most striking comparison between the costs of direct delivery from $ORIGIN_1$ and from $ORIGIN_2$ is the larger average costs of delivery from $ORIGIN_2$. The greater distance of $ORIGIN_2$ from the market area is the primary factor causing the higher average costs of intracity delivery from this origin. This relationship is demonstrated by comparing the costs of IDS_2 and IDS_7 which have the same parameters of truck size (300-case) and time (720 minutes) but have different origins ($ORIGIN_1$ and $ORIGIN_2$ respectively). The average cost of IDS_2 is .1863 dollar compared to .4643 dollar for IDS_7 (Table VI-4). Direct intracity delivery is 2.5 times more costly from a point 112 miles from the market area relative to delivery from a point within the market. For a firm located at the latter point, the advantage in direct delivery over a more distant firm is quite great. This advantage is not only reflected in average delivery costs but also in the quantity of truck and driver resources required. For example, twice as many

trucks are needed for intracity delivery from the more distant origin. And three more drivers are required. For a firm at Origin 2 direct delivery requires a larger investment in trucks and the acquisition of more drivers.

TABLE VI-4.--Comparison of direct delivery costs from an origin close to the market and from a more distant origin.

Origin ^a	Average Cost ^b	Resources Required	
		Trucks	Drivers
	(dollars)		
ORIGIN ₁	.1863	2	4
ORIGIN ₂	.4643	4	7

^aORIGIN₁ is within the urban market. ORIGIN₂ is approximately 112 miles from ORIGIN₁.

^bAverage cost of IDS₂ and IDS₇, respectively.

The effect of distance from the market on average intracity delivery costs and the quantity of truck and driver resources needed has been demonstrated by use of this set of data which represent a specific situation. But in general these relationships would apply to a large number of cases where eggs are distributed from processing points to retail stores in urban market areas. For firms involved in egg distribution, this analysis indicates how cost and resource requirements vary directly with distance from the market. And furthermore the capability for using

drivers and trucks both in delivery and assembly operations may be restricted as distances in direct intracity delivery increase. The capability for using vehicles and drivers in both operations is closely tied to how well a firm can plan and implement operationally efficient assembly and delivery functions. But as distance from the market area increases, direct intracity delivery decreases the availability of trucks and drivers for use in assembly. Consequently, direct delivery may require greater total investment in vehicles and more drivers than would bulk shipments to single destinations.

To demonstrate the relation between the costs of direct delivery and line-haul cost as distance from the market area increases, data from this specific analysis of the Detroit SMA are utilized. In Figure VI-1 direct delivery cost per case is plotted against distance from the market (line A). At point zero on the distance scale the cost of direct delivery from $ORIGIN_1$ is plotted. The cost used is the average cost of IDS_2 which utilizes the 300-case truck. At this point, which is in the Detroit SMA, direct delivery (to the stores in this study) costs .1863 dollar per case. At a distance of 112 miles on the horizontal scale, the average cost of direct delivery from $ORIGIN_2$ (IDS_7) is plotted. Between the two points, zero and 112, it is assumed that the cost of direct delivery increases linearly. And the broken portion of line A is

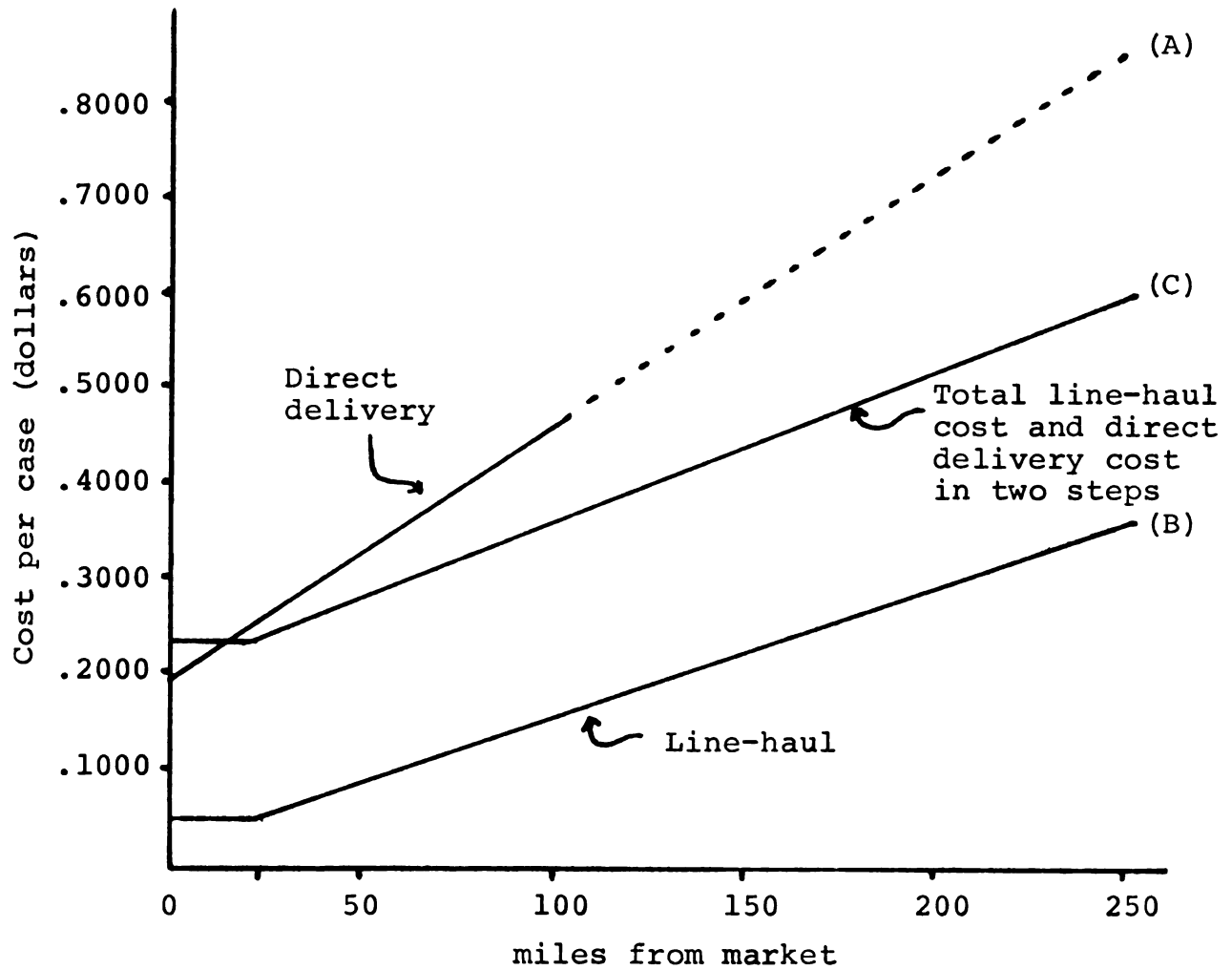


Figure VI-1. Relationship between direct delivery cost and line-haul cost as distance from the market increases.

a projection of this relationship beyond the scope of the data. Line-haul cost is also plotted against distance from the market (line B). This line represents the cost of line-hauling 700 caseloads of eggs from given distances from the market to ORIGIN_1 . Line-haul costs are estimated from the equation presented in Chapter V. The line is drawn so that it flattens out from zero to twenty-five miles. This reflects the fixity of some line-haul costs not entirely associated with distance [20].

It can be seen that direct delivery to stores from any point on the horizontal scale costs more than line-hauling from the same point to ORIGIN_1 . At a point ten miles from ORIGIN_1 , direct delivery costs .1700 dollar per case more than line-hauling to ORIGIN_1 . And at a distance of 110 miles from the market, direct delivery costs .2925 dollar per case more. The difference is .4200 dollar per case at a point 230 miles from the market. For a firm the choice between direct delivery and line-hauling (bulk shipments) has to be evaluated with knowledge that direct delivery will be more costly and will likely require a greater investment in vehicles and more drivers. There may be trade-offs between higher delivery costs and the greater control over major outlets derived from direct contact with buyers. And the cost difference increases directly with distance from the market.

In terms of total delivery cost, line C represents the cost of line-hauling from a given point to ORIGIN_1 and the cost of intracity delivery (IDS_2) from ORIGIN_1 to stores. This line indicates what total transportation costs are--both line-haul and intracity delivery--when two separate transport activities are needed. It is obtained by adding the cost of intracity delivery (from ORIGIN_1) to line B. Comparing line A with line C indicates that up to a point about twenty miles from the market, direct delivery is less costly than is line-hauling to ORIGIN_1 and delivery from there to stores. Beyond twenty miles direct delivery is more costly. From the standpoint of operational efficiency in egg distribution, this relationship implies that egg firms which are located beyond twenty miles from their major urban market area should not be involved in direct delivery. However, this implication is based on specific cost information and does not consider other factors such as actual location of production and egg distribution firms relative to given urban markets. And warehousing cost is not added into line C which would reduce the margin.

For an egg firm at a given location from its major urban market, the cost of direct delivery and the effect of direct delivery upon total truck and labor resources must be evaluated in view of the potential revenues from direct delivery versus the cost and revenue from line-hauling or bulk shipments.

Alternative Channels for the
Integrated Firm

Both INTDCS2 and INTICS1 are alternative channel systems for the integrated firm. But as will be shown this latter system offers no advantages over the present channel. Each channel is discussed relative to the present system, INTICSP.

INTIDCS2

In this channel eggs are delivered direct from the plant to stores. The firm has an option of five different intracity delivery methods: (1) IDS_3 (700-case truck, 840 minutes); (2) IDS_4 (300-case truck, 840 minutes); (3) IDS_5 (700-case truck with one set of drivers shuttling trucks from the plant to the market and return and a second set running the routes); (4) IDS_6 (700-case trucks, 720 minutes); and (5) IDS_7 (300-case truck, 720 minutes).

Excluding IDS_5 , INTDCS2 with any of the other delivery methods has a channel cost which is .0400 to .1100 dollar greater than the cost of the present system (Table VI-5). These methods require drivers to reside in the area in which the egg plant is located since each driver runs a route from the plant to stores and return. This factor can create problems associated with relocation of drivers from Detroit or the hiring of additional new drivers in the area of the plant. The role of union influence upon driver utilization and location may be a

TABLE VI-5.--Costs of INTDCS2.

Cost	INTDCS2 with:				
	IDS ₃	IDS ₄	IDS ₅	IDS ₆	IDS ₇
Intracity delivery cost, UCST _j	.4483	.4515	.3950	.5705	.4643
Intracompany transfer cost	<u>.1224</u>	<u>.1224</u>	<u>.1224</u>	<u>.1224</u>	<u>.1224</u>
Channel cost	.5707	.5739	.5174	.6929	.5867

crucial factor. If the firm were to consider these methods, then some evaluation of the trade-offs between delivery costs, investment cost ratios, and driver requirements is necessary. If minimization of drivers is a goal, then IDS₃ offers this advantage with an accompanying larger investment in trucks relative to the 300-case truck methods. If drivers cannot operate for fourteen hours then IDS₆ or IDS₇ which have twelve-hour restrictions are preferable to IDS₃ or IDS₄, even though the former methods are lower cost. A choice between IDS₆ and IDS₇ centers on the lower investment cost and lower delivery cost of IDS₇ since both require the same number of drivers.

More realistically, IDS₅ is the method which is a more logical alternative. INTDCS2 with this option has a channel cost of .5174 dollar per case compared to .5292 dollar per case for INTICSP. But the cost difference is insignificant. Other criteria such as faster delivery and

less handling favor direct delivery. Since IDS_5 requires one-two drivers to operate out of the plant and four drivers to reside in the Ann Arbor area this method does not have the potential problem associated with relocating (or hiring new drivers) drivers in the area of the plant. And relative to other methods it requires only two 700-case trucks (at most a 1.9 investment cost ratio compared to 300-case truck methods). This method is more likely to be integrated into the firm's interchange system which uses the egg plant as a terminal.

INTDCS2 with IDS_5 offers the advantage of quicker delivery and less handling of eggs. These must be viewed as important criteria favoring the direct channel. The adoption of the direct channel system is contingent upon other factors relative to the firm's overall distribution system centering on the distribution warehouse. The present egg distribution system is integrated into the total distribution operation which is being restructured to consolidate more products into single loads for store delivery. This is an attempt to reduce drivers' work loads and potentially to improve their efficiency. The initiation of a direct delivery channel for eggs would be inconsistent with the overall goal. Not only that but bypassing the distribution center removes the contribution that eggs make to warehouse operating expense. This would provide opposition to change since increasing operating costs require additional

off-setting contributions to warehouse expense. For the integrated firm the choice of an alternative egg distribution system cannot be made solely on the criterion of cost at least within the narrow margin of cost difference between the direct channel and INTICSP. Trade-offs between direct delivery and the present channel require evaluation.

INTICS1

This channel is a potential system for the integrated food chain. In the channel, eggs are line-hauled from the egg plant to the distribution center at $ORIGIN_2$. Then IDS_1 or IDS_2 is an option for intracity delivery. In contrast to the present system, eggs are delivered in single-product loads to stores. Table VI-6 gives channel costs.

TABLE VI-6.--Costs of INTICS1.

Cost	INTICS1 with:	
	IDS_1	IDS_2
	(dollars per case)	
Line-haul cost, LHC (112 miles)	.1718	.1718
Warehouse cost, DWHC	.1150	.1150
Intracompany transfer cost, CTCRC	.1224	.1224
Intracity delivery cost, $UCST_j$	<u>.1778</u>	<u>.1863</u>
Channel cost	.5870	.5955

Because of the minimal cost difference between IDS_1 and IDS_2 the option of which size of truck to employ is based upon other factors. Even though a greater investment is required for the 700-case trucks, this is not as crucial. In the firm's overall physical distribution system in the Detroit market the larger trucks are used most extensively. It is likely that two trucks could be assigned to the egg distribution system. And smaller trucks are used in meat deliveries. The choice of the intracity distribution method would have to be made considering the availability of trucks within the present operations and alternative uses of new trucks if required.

As an alternative channel for the integrated firm this system does not bypass the distribution center. This channel would not result in any less handling or any faster delivery to stores than does the present channel. And the cost of the alternative channel is about .0600 dollar per case more than the cost of INTICSP. If the firm were to adopt specialized egg deliveries, more consideration would be given to direct deliveries from the plant in order to reduce handling and increase the speed of delivery. INTDCS2 would offer the advantages of less handling and quicker delivery at a lower cost than this system.

Cost of Synthetic Channel Systems

These channel systems are synthetic in that they are not potential channels for the integrated food chain

but are characteristic of existing large-scale independent and integrated channels. They provide a comparison of costs between integrated and independent channels.

INTDCS1

This is an integrated channel which assumes that the food chain has a processing plant at the location of the distribution center. (Some distribution centers have processing plants located on the premises.) In this channel eggs must be assembled and delivered to the plant for processing. The capability of the firm for performing the assembly function efficiently is the major constraint on the successful operation of the channel. The availability of eggs in sufficient quantities from producers close to the urban market is an important consideration. Since the trend is for egg production to be located greater distances from metropolitan areas, the volume of eggs available from producers in close proximity is likely to become less. Public pressure on poultry producers in urban areas is becoming greater due to the pollution aspects of production.³ The trend of decentralization of grading and cartoning to country points reflects the concentration of production in more rural areas.

³See for example Robert E. Linton, The Economics of Poultry Manure Disposal, New York State College of Agriculture, Cornell Extension Bulletin 1195 (Ithaca, N.Y.: Cornell University, 1966). This report details some of the problems facing producers in an urban resort area.

If the firm could efficiently assemble eggs from large producers geographically concentrated, then the channel would be more operable. In order for the system to operate smoothly, considerable regularity of trading relationships between the firm and distant producers would be required. The establishment of such relationships would permit a continuous flow of eggs to the urban plant. Either the firm or large-scale producers could assume the transport function.

This channel is less realistic than other synthetic channels. Food chains which have invested in egg processing plants have located plants within rural production areas in order to minimize assembly problems and to more efficiently utilize processing plant capacity. In these cases, integration into processing was undertaken to attain a more constant and stable supply of eggs. This was considered best done by location near supply sources. And those food chains which have invested in both production and processing facilities have located both in the same location to eliminate the assembly function.

The firm has an option of either IDS_1 or IDS_2 . Cost of the channel is nearly the same with either method (Table VI-7). A limitation on capital would make IDS_2 more preferable. The cost of this channel is considerably lower than the cost of INTDCS2, primarily due to location of the processing firm. Relative to the integrated channel from $ORIGIN_2$, the firm in this channel has a decided advantage

in its capability for lower cost direct delivery. This advantage is obtained at the cost of potentially greater assembly or acquisition activities. Even for the firm in this channel, the preferability of direct egg delivery versus distribution of eggs with other products requires evaluation in a total distribution system context.

TABLE VI-7.--Costs of INTDCS1.

Cost	INTDCS1 with:	
	IDS ₁	IDS ₂
	(dollars per case)	
Intracity delivery cost	.1778	.1863
Intracompany transfer cost, CTCRC	<u>.1224</u>	<u>.1224</u>
Channel cost	.3002	.3087

INDDCS1

This channel assumes an independent processing firm located at ORIGIN₁. The firm sells eggs to a large food chain and delivers direct to stores. For the firm the choice of either IDS₁ or IDS₂ focuses upon the 3.84 greater capital investment for trucks in the former method. The smaller trucks could be utilized in assembly if deliveries to stores are made at night. Often food chains and suppliers do not want drivers to operate in certain urban areas at night. Food chains attempt to minimize the number of people who have access to unloading docks and store

storage facilities. These factors may prohibit night deliveries and consequently eliminate the use of trucks in assembly.

This channel has the comparable problem of assembly that the preceding channel, INTDCS1, experiences. If a continual supply of eggs is not available to the firm through its trading relationships with producers, then the firm's ability to efficiently distribute eggs as required by the food chain is reduced. Consequently any market advantage it may have over more distant processors is affected. The firm's close proximity to the market permits it to distribute eggs direct to stores at a lower cost--more operationally efficient--than a processor at ORIGIN₂. The degree to which the firm can maintain this greater efficiency is closely related to its capability for assembling eggs. For the independent firm, capital restrictions can prevent the development of production facilities outside the urban market. By developing its own production capabilities, it would be in a better position to meet the requirements of the food chain, provided it has the technical ability for efficient production.

For this channel the communications costs and intra-city delivery cost are comparable to INTDCS1 (Table VI-8). The cost of INDDCS1 is approximately the same. This is an important point. It indicates that when a food chain and an egg processor negotiate through the market process to

initiate direct delivery as required by the food chain, this channel operates at an approximate level of distribution cost as the integrated channel. A major factor affecting the competitiveness of this independent channel is the stability in processor-food chain trading relations. This factor is examined in more detail later in this chapter.

TABLE VI.8.--Costs of INDDCS1.

Cost	INDDCS1 with:	
	IDS ₁	IDS ₂
	(dollars per case)	
Processor's sales cost, IPSC	.0818	.0818
Food chain's purchase cost, CSPC	.0447	.0447
Intracity delivery cost, UCST _j	<u>.1778</u>	<u>.1863</u>
Channel cost	.3043	.3128

INDDCS2

In this channel a processor at ORIGIN₂ sells to a food chain in the Detroit SMA and delivers direct to its stores. The processing firm has an option of five intracity delivery methods: (1) IDS₃; (2) IDS₄; (3) IDS₅; (4) IDS₆; and (5) IDS₇.

For any of the delivery methods, five to seven drivers are needed. The availability of qualified drivers affects the efficiency of delivery operations. Of the

methods IDS_5 is the lowest cost but requires drivers to live within the Ann Arbor area. For the independent firm this requirement could restrict the firm from using the method. This is contingent upon the firm's ability to acquire and maintain drivers in that area who are not involved in any other phase (assembly) of the firm's operations. Since IDS_5 is more complex than those methods in which all drivers return to plant, the initiation of the method must be evaluated in relation to how long-run the firm is to be distributing eggs to the food chain. If the firm were to terminate relations with the food chain and negotiate with another, then it is questionable that the same sort of delivery method could be used. Relative to the integrated firm, the independent firm faces more uncertainty in developing direct intracity delivery methods which are fairly complex.

If the firm adopts an intracity delivery method in which all drivers return to the plant, then a 300-case truck method permits the use of trucks for some assembly if deliveries are made at night to stores. The investment costs are also lower. Day delivery reduces the potential use of trucks for assembly. This indicates that the adoption of direct delivery to stores can increase the total investment required in trucks for delivery and assembly activities. Limitations on capital can prevent a firm from developing direct store door delivery capability. Operating within a time constraint of twelve

hours per day makes the 300-case truck more preferable since it is lower cost due to greater utilization of truck capacity.

This channel system has the lowest cost when IDS_5 is used (Table VI-9). With the exception of IDS_6 (700-case trucks) costs of the other intracity delivery methods are within close range of one another. Relative to the integrated direct channel (INTDCS2) cost employing any of the five delivery methods, the independent channel system has comparable costs. If the firm is incapable of initiating IDS_5 , then the cost of the channel system utilizing the next best alternative (IDS_4 or IDS_7) is about .0600 dollar greater than INTDCS2 using IDS_5 .

TABLE VI-9.--Costs of INDDCS2.

Cost	INDDCS2 with:				
	IDS_3	IDS_4	IDS_5	IDS_6	IDS_7
Processors sales cost, IPSC	.0818	.0818	.0818	.0818	.0818
Food chain's purchase cost, CSPC	.0447	.0447	.0447	.0447	.0447
Intracity delivery cost, UCST _j	<u>.4483</u>	<u>.4515</u>	<u>.3950</u>	<u>.5705</u>	<u>.4643</u>
Channel cost	.5748	.5780	.5215	.6970	.5908

The competitiveness of the two channel systems (distribution cost criteria) is affected by the processing firm's capability for adopting the necessary delivery method. This in turn is related to the length of run of relationships between the firms and the availability of capital for financing truck requirements for delivery and assembly as well as the availability of labor. All these factors can combine to prevent such a channel system operating from $ORIGIN_2$. The profitability of direct store delivery is related directly to the level of prices negotiated. The real financial burden, truck investment and driver costs, is placed upon the processing firm and consequently in such cases direct deliveries are often not feasible. Instead processors deliver to food chains' distribution centers in truckload lots. This reduces truck investment costs for delivery and enables the firms to have more flexibility in financing and operating assembly activities. If the firm at $ORIGIN_2$ delivered to the distribution center and the food chain distributed eggs in mixed loads (as does the integrated chain), the cost of this channel would be .5333 dollar, which is of comparable costs with INTICSP and INTDCS2. This assumes the independent food chain has the same warehousing cost and intracity delivery cost as the integrated chain.

INDICS1

This is an independent intermediary channel system. Eggs are sold by the processor at ORIGIN_2 (or other origins) to a wholesale distributor at ORIGIN_1 within the urban market. The wholesale distributor sells and delivers direct to a large food chain. This channel system is characteristic of more complex channels in which eggs move from country points to urban wholesale distributor to retail stores [35]. The development of these channels results from the distance of processors from urban markets. Cost prevents processors from delivering direct to stores. (But processors do deliver to food chains' distribution centers. The choice of selling to wholesale distributors versus sales to retail food chains is affected by competitive factors and distance. See discussion of INDDCS2.)

For the wholesale-distributor, IDS_2 is the better alternative primarily because of the considerably smaller investment required. The trucks could partially be used in assembly. Relative to other channel systems this channel has three separate firms involved. Four communication costs result (Table VI-10). In addition, warehousing and line-hauling costs are necessary. Channel cost is .7036 dollar per case. The increase in channel cost, as the processing firm is located greater distances from the market, explains in part the larger marketing margins in certain urban areas where marketing channels are more complex [34]. If the processor were located at ORIGIN_4

TABLE VI-10.---Costs of INDICSL.

Cost	INDICSL with:	
	IDS ₁	IDS ₂
Line-Haul cost, LHC _{mn}		
ORIGIN ₂ ^a (110 miles)	.1718	.1718
ORIGIN ₃ ^a (200 miles)	.2950	.2950
ORIGIN ₄ ^a (250 miles)	.3650	.3650
Processor's sales cost, IPSC	.0818	.0818
Whsl.-dist. purchase cost, IDPC	.0425	.0425
Whsl.-dist. sales cost, IDSC	.0700	.0700
Warehouse cost, DWHC	.1150	.1150
Intracity delivery cost, UCST _j	.1778	.1863
Food chain's purchase cost, CSPC	.0447	.0447
Channel cost	.7036 ^b	.7121 ^b
	.8268	.8353
	.8968	.9053

^aThese origins are included to demonstrate how channel cost increases as the distance between the processor and wholesale distributor increases.

^bCosts with line-haul from present plant location.

channel cost would be .8968 dollar per case. Channel cost is considerably larger than the costs of direct channels analyzed. With more firms, duplication of handling and transport functions is characteristic of the channel.

Compared to a direct channel with delivery from a processor at ORIGIN₂ direct to stores, this channel is .1200 to .1800 dollar per case more costly. But this difference would dissipate rapidly if the processor were located at ORIGIN₃ and attempted direct delivery. Increasing cost of direct delivery would tend to affect the costs of this intermediary channel. As noted, a processor at ORIGIN₂ could sell eggs to the food chain and deliver them to the warehouse. In such a channel the food chain would deliver eggs to stores in mixed loads. The approximate cost of this channel is .5333 dollar per case, which is lower than the cost of INDICS1 (.7036 dollar).

A variation of INDICS1 would be for wholesale distributors to deliver to the food chain's distribution center. In such a channel, the cost would be about .2500 to .3000 dollar per case greater than INDICS1 since there would be a warehousing cost and an intracity delivery cost created by the food chain. In this channel variation there would be three separate transport movements and two different handlings in warehouses. The channel cost would be approximately 1.00 dollar per case from point of processing to final retail outlet. And eggs would spend more time in

the channel. Relative to direct channel systems the cost is two times as great.

Effect of Volume on Channel Costs

In this analysis it was assumed implicitly that either an independent firm or an integrated firm could perform equally efficient the intracity egg delivery function. For the integrated food chain the same channel system exists continually over time with only minor modifications. This makes the efficient delivery of eggs easier to accomplish since intracity delivery can be planned with no uncertainty as to where eggs are distributed. For the integrated food chain eggs flow from processing plant to retail outlets with a high degree of regularity subject only to minor variations. For the independent processing or distributing firm stable trading relationships with buyers are necessary in order for the firm to develop and implement efficient intracity delivery.

The purpose here is to examine the effect of changes in the volume of eggs flowing through an independent channel system upon channel cost. Changes in the volume of eggs flowing through a channel system are the result of major variations in buyer requirements or the termination of a trading relationship between an egg firm and a buyer. Volume changes can have a major impact on the quantity and allocation of truck and labor resources for the egg firm. And for both the egg firm and the buying firm termination

of trading relationships may result in greater sales and procurement costs respectively as new buyers (suppliers) are sought.

An egg distributing firm which has established stable trading relations with a food chain and which has planned and implemented the feasible-optimal delivery method (via the Lockset method or other technique) may still experience problems such as delay in order communications, unforeseen minor variations in supplies required by the food chain, or low labor productivity. Any factor which results in increased labor needs or in additional miles in intracity delivery which is efficiently designed and operated tends to increase delivery cost. However, a coordinated channel system places channel members in a better position to correct and adjust to these problems relative to firms in a less coordinated channel.

The greater impact on an egg firm's operating costs and consequently the channel system's cost arises from a major change in the trading relation between the firm and the customer food chain. To demonstrate the potential impact of such changes in trading relations it is assumed that the independent processor in INDDCS2 and the large food chain are presently tied together via the market into a channel system. The food chain purchases 75 per cent (5400 cases) of the processing firm's weekly output. This is the normal level of trading relations between the firms.

At this level of operation intracity delivery cost (to the food chain) (IDS_4) is .4643 dollar per case and the processing firm's in-plant cost is 1.5300 dollars per case. This latter cost includes sales cost of .0818 dollar per case (see Table III-3). Total intracity delivery cost and in-plant cost is 1.9900 dollars per case (Table VI-11).

(Although channel costs in the preceding analysis did not include in-plant costs they are considered here to demonstrate that in-plant costs are affected when major changes occur in volume flowing through a channel.)

With a decrease in volume required by the food chain, the processing firm finds itself in an interim period with an excess amount of eggs for which no buyer exists. By reducing plant output for an interim period, the plant manager adjusts to this situation. However, during such a period of reduced output, the plant manager may find it more acceptable to maintain the work force to assure their presence when needed for normal operations [34]. Therefore, plant wages do not decrease as output does. Constant unit operating costs (packaging materials, etc.)--which vary directly with output--are reduced. For drivers used in delivery, those not needed for distributing the reduced output likely continue to receive wages since the cost of laying off and reacquiring drivers may be as great as normal wages. And for unused trucks, fixed costs accrue. In general, a reduced volume of eggs must

TABLE VI-11.--Total intracity delivery and processing cost at different levels of operation.

Cost Item	Average Cost per Case at an Output Level of:			
	(cases per week)			
	7200 ^a	6300	5400	1800
	(dollars)			
Intracity delivery ^b	.4643	.5720	.6690	.9800
In-plant cost ^c	1.5300	1.9400	2.1900	3.5000
Total	1.9900	2.5100	2.8600	4.4800

^aNormal level of output for the processing firm.

^bAssumes that IDS7 is the method of intracity delivery and that at an output level of 7200 cases this method is most efficient. Costs at different levels of output derived by assuming that total drivers wages remain same regardless of output. The same assumption is made for fixed truck costs. Variable operating costs per mile for trucks used in delivery estimated by assuming the same miles per case coefficient at each level of output. At 1800 cases per week, no trucks or drivers in IDS7 are utilized. These costs must be allocated to the cost of delivering the remaining 25 per cent of firm output. The intracity delivery cost given would be the additional cost.

^cIncludes all in-plant costs including sales. Derived by assuming that only constant unit operating costs decrease as volume is reduced. All other costs remain stable for an interim period.

bear the same level of plant wages, fixed plant costs, driver's wages, and fixed delivery truck costs which exist when the firm has a normal level of operation. The effect on average cost per case is directly related to the degree of reduction in output. For example, if the food chain reduces its volume purchased from the processing firm by

900 cases, total intracity delivery and in-plant cost increases to 2.51 dollars per case (Table VI-11). This assumes the 25 per cent of firm output purchased by other buyers remains constant. If the reduction in volume is 1800 cases (33 per cent of the food chain's normal purchase) then cost increases to 2.8600 dollars per case. And at the extreme, if the food chain terminates completely its purchases, cost increases to 4.4800 dollars per case. In this case the volume to other outlets remains the same but must bear the cost of the unused truck and labor resources previously used in delivering to the food chain.

It should be emphasized that these cost changes represent a maximum impact of volume change and that these variations are only for an interim period. In addition, the costs do not include the food chain's purchase cost. It is extremely difficult to generalize about how this cost might be affected by major changes in trading relations. However, in many cases, establishment of new suppliers may increase cost. Also these costs do not include any costs to the processing firm associated with payments made to secure a buyer.⁴

⁴The NCFM [31, p. 53] reported: "Exchange practices have reflected the stronger bargaining positions of buyers. . . . Allowances have taken a variety of forms: quantity discounts . . . advertising allowances, and price reductions. . . . In some instances, bribery, case payments and gifts from sellers to buyers have been involved. . . . Egg handlers frequently have granted concessions to retailers for the privilege of becoming suppliers of new stores and to avoid losing accounts."

In terms of channel system cost, this analysis indicates that the competitiveness of independent channel systems with integrated channel systems can be significantly reduced if there are major variations in the volume of eggs flowing through the independent channel. Changes in volume of eggs purchased by the food chain can increase the processing and delivery costs for the egg firm by causing a situation where the egg firm in an interim period maintains the same general level of costs but reduces output. While in this case increased average costs accrue to the processing firm, such costs must be viewed as increases in channel system cost.

Bargaining Power and Channel Systems

This analysis has demonstrated that an independent channel system composed of firms who have coordinated the flow of eggs by the market process can be as operationally efficient in distribution as a food chain integrated into egg processing. The cost differences between the independent channel system and the integrated channel are minimal. The difference was less than .0100 dollar per case between the independent and integrated channel systems from either $ORIGIN_1$ or $ORIGIN_2$ (Table VI-12). However, as was noted, the operational efficiency of the independent channel system is closely dependent upon a stable trading relation between firms in the channel system. Major variations in trading relations which affect volume have

a great impact upon channel costs. Consequently, the willingness of independent firms to develop channel systems is a major factor affecting distribution channel costs. And bargaining power of channel firms likely is a crucial element in determining the willingness to develop fairly continuous channel systems.

TABLE VI-12.--Comparison of channel costs for INTDCS2 and INDDCS2.

Cost Item	Integrated	Independent
	INTDCS2	INDDCS2
	(dollars per case)	
Intracity delivery cost	.4643	.4643
Processor's sales cost	--	.0818
Food chain's purchase cost	--	.0447
Intracompany transfer cost	<u>.1224</u>	<u>--</u>
Channel cost	.5867	.5908

Bargaining power may be thought of as the ability of a firm to negotiate favorable terms of trade with suppliers (customers). In the market egg industry, exchange practices have reflected the stronger bargaining position of buyers. Food chains have tended to enjoy greater bargaining power relative to egg firms. The greater bargaining power of food chains and other buyers raises a question as to the willingness of these firms to develop channel systems with egg firms over any long period of time.

While the advantages of known outlets for egg firms are great (efficient delivery methods, stable output, etc.), for major buyers the advantages of continuous volumes of eggs may be offset by the potential for extracting better terms of trade from other suppliers. In terms of an independent channel system, channel firms must decide how the benefits of improved coordination are to be distributed. Bargaining power is likely to be the deciding factor in this case. Unlike the integrated food chain, independent food chains may not have to absorb increases in distribution cost (driver labor, etc.) because of their potential ability to force all or part of cost increases onto their suppliers.

Cost Comparison of Large-Scale Channel Systems with Small Channels

In this research focus has been on large-scale channel systems in which channel members are coordinated either by the administrative or exchange process. The flow of eggs through either kind of channel system was considered to be highly efficient. To demonstrate the distribution cost advantage of these larger channel systems over smaller less coordinated channels, unpublished data from an Ohio and Michigan study of egg distribution are utilized.

From the Ohio and Michigan study a sample of eight routes from egg packer to retail stores were analyzed. Using average values for these routes the following composite route was defined: (1) total route time, 8.3 hours; (2) total miles, 140; (3) total cases, 154; (4) number of

stores, 14. In terms of length this average route is comparable to those from ORIGIN₁ utilizing a small truck. The average cost of this composite route was .4689 dollar per case. In Table VI-13 estimated channel cost for this smaller channel is compared to the cost for the large-scale channel--INDDCS1. Presented are the delivery cost and in-plant cost which includes sales cost for both the large processing plant (7200 cases per week) and the smaller plant (900 cases per week). Also purchase costs for the large food chain and the smaller retail outlet are given. It is assumed that purchase cost for the latter firm is higher. Cost for INDDCS2 is 1.7655 dollars per case compared to 2.4527 dollars for the smaller channel.

The higher cost for the smaller channel reflects a number of factors. One is the greater economies of scale in the larger egg plant. This affects both sales and processing costs. In terms of purchase cost for retail stores, economies of scale are also reflected in the lower purchase cost for the large food chain. In terms of intra-city delivery the most obvious factor affecting costs is the relatively smaller volumes required by buyers in the smaller channel. Loading and unloading efficiency decreases as volume decreases. Smaller deliveries require more time per case. In many of the smaller routes drivers were delayed at the delivery point for various reasons. Drivers occasionally served as salesmen receiving orders

for future delivery and collecting for current delivery. It is also probable that the most feasible routes were not followed. In addition, drivers sometimes were forced to wait at the egg plant until all incoming orders were received and loads prepared. In general the distribution routes examined were not really systems in the context of physical distribution activities being closely coordinated. It appears that substantial improvements in operational efficiency could be made among firms in smaller channels.

TABLE VI-13.--Comparison of channel costs between a large-scale channel system and a small less coordinated channel.

Cost Item	Cost per Case:	
	INDDCS1	Small Channel
	(dollars per case)	
Intracity delivery cost	.1863	.4689
In-plant cost ^a	1.5345	1.9238
Chain store purchase cost	.0447	--
Retail store purchase cost	--	<u>.0600</u>
Total channel cost	1.7655	2.4527

^aIn-plant cost includes processing and sales cost. In-plant costs taken from Yergatian and Storey [45]. The in-plant cost difference would narrow as the scale of the smaller plant approached that of the large plant.

CHAPTER VII

SUMMARY AND IMPLICATIONS

Review of Problem and Procedure

The primary objective of this study was to estimate and compare the costs of moving market eggs through alternative distribution channel systems into retail stores in a large urban market. This study focused upon distribution costs of alternative methods of moving market eggs from the point of processing to retail food stores. This segment of the total market channel was analyzed primarily because of a previous lack of factual information concerning distribution costs. A secondary objective was the analysis of factors affecting costs among alternative methods of intracity delivery. Intracity delivery is the physical movement of eggs from a given point to a multiple number of retail food stores.

A distribution channel system was defined as being composed of firms which closely coordinated the flow of eggs from processing plant to retail stores. Both integrated channel systems and independent channel systems were analyzed. In the former a food chain had ownership of an egg processing plant and all the plant's output was distributed through the firm's stores. In the latter channel, firms were under separate ownership but closely

coordinated egg flows via use of the market process. For both integrated and independent channel systems, direct and intermediary channel types were evaluated. Factors affecting costs among alternative distribution channel systems were examined. And the effect of administrative (ownership) and exchange (market) coordination upon distribution channel costs was analyzed.

The general procedure used required the specification of alternative distribution channel systems. The urban market focused upon was the Detroit SMA. This market was selected because of its representativeness of urban markets; the availability of data; and the presence of a large food chain, integrated into egg processing, which cooperated in this research. Data concerning the Detroit market were provided by the integrated food chain and taken from secondary sources. The firm's present and potential channel systems were costed and compared. From primary and secondary data, synthetic large-scale independent channel systems were specified and costed. The major distribution costs considered were transportation, warehouse, and communications. The comparison of costs among alternative channel systems focused upon the relevant channel members' distribution costs.

Summary of Primary Results

Distribution Channel Systems

1. The average cost per case of the integrated food chain's present egg distribution system was estimated to be .5292 dollar. In this system eggs are line-hauled from the firm's egg processing plant (ORIGIN₂)--about 112 miles from the Detroit SMA--to the distribution center warehouse. There the eggs are unloaded and stored temporarily (an average of one day or less). Eggs are delivered to retail stores in mixed loads with produce items. The large-scale operation of the firm's Detroit market distribution center was evident by the number of stores served and the large number of drivers and vehicles employed in distribution operations. The present egg distribution system is integrated into the total distribution center delivery system. And the operational efficiency of the egg distribution system appeared to be satisfactory. However, the scale of operation of the total distribution system and problems of low driver productivity in delivery have caused the firm to re-evaluate present delivery systems and to plan for the consolidation of more products into single loads for store delivery. Presently, five different kinds of deliveries are made to stores--dairy, groceries, frozen food, meat, and produce.

2. Because of the potential advantages of faster delivery and less handling--which tend to decrease the possibility of egg quality deterioration--an alternative direct channel system for the integrated food chain was evaluated. In this alternative channel eggs are delivered direct from the egg plant to retail stores. Eggs bypass the distribution center and consequently egg distribution is not an integral part of the total system. By use of the Lockset method of sequential programming, alternative intracity delivery methods were evaluated in terms of cost. The lower cost method of delivery utilized one-two drivers to shuttle 700-case trucks to Ann Arbor area stores (100 miles from the plant and 12 miles from the distribution center) where they were taken through routes by a different set of drivers. The average cost per case of this alternative direct channel system was estimated to be .5174 dollar. In an economic sense the cost difference between this direct channel and the present channel system was insignificant. A choice between the two channel systems would have to be made on the basis of other criterion such as what the effect of direct delivery would be on the total distribution system.

3. A synthetic channel system in which an independent processor at ORIGIN₂ sells and delivers directly to a large food chain's stores was specified and costed. The average cost per case of this channel system with the

processor utilizing the most operationally efficient intra-city delivery method was .5215 dollar. If because of capital limitations on truck investments, scarcity of drivers, or cost-revenue considerations the processing firm cannot implement direct delivery, an alternative channel system is delivery to the food chain's distribution center. In this channel system eggs would be line-hauled from the processing plant to the distribution center. From the distribution center eggs would be delivered to retail stores. Average cost per case in this intermediary channel system would be .5333 dollar. The small cost difference between the two channel systems is due to the fact that the additional channel costs of line-hauling and warehousing are offset by the relatively large cost of direct delivery.

4. Between the large-scale independent direct channel systems with the processing firm located at $ORIGIN_1$ and $ORIGIN_2$ the former system had a distribution cost advantage. For the channel system with the processor located at $ORIGIN_1$, average cost per case was .3043 dollar. Average channel cost per case with the processor at $ORIGIN_2$ was .5215 dollar. The primary factor explaining the cost difference was the capability of the processor at $ORIGIN_1$ --in the market area--to deliver eggs at lower cost per case. However, the competitive advantage of this processor was contingent upon the firm's ability to efficiently assemble eggs. Although assembly costs were not included in the

analysis, the consideration of assembly costs would reduce or eliminate the competitive advantage of the firm close to the urban market.

5. The average cost per case of the independent intermediary channel system in which a processor at $ORIGIN_2$ sells to a wholesale distributor at $ORIGIN_1$ who in turn sells and delivers to stores of a large food chain was estimated to be .7036 dollar. This channel system which is representative of more complex channels had a cost which is .1200 to .1800 dollar per case greater than costs in a direct channel system from $ORIGIN_2$. Most of the cost differences are explained by the duplication of transport and handling functions relative to the direct channel system. As the processing firm is located greater distances from the market, increasing line-hauling costs inflate channel costs. At a point 250 miles from the market, channel system cost is .8968 dollar per case. If the wholesale distributor delivered to the food chain's distribution center from which eggs were delivered to stores, channel system cost would be approximately 1.0000 dollar per case. Cost of this channel system is two times larger than the cost for the direct channel system.

6. The large-scale channel systems evaluated in this research were found to have significant distribution cost advantages over smaller less coordinated channels. A comparison of channel costs for a large-scale direct

channel system with the cost of a smaller less coordinated channel indicated that the former channel had an average distribution cost per case which was 25 per cent less.

7. A most important result of this study was the distribution cost relationship between the integrated channel systems and the large-scale independent channel systems. More specifically, there was no important cost difference between the integrated direct channel system and the independent direct channel system. The communications and intracity delivery costs for the independent channel in total approximated the communications and delivery costs for the integrated food chain. Coordination by either the administrative or exchange process resulted in the same level of distribution cost. The operational efficiency of the independent channel system and its competitiveness with the integrated channel system was dependent upon a stable trading relation between the processor and the food chain. As the volume of eggs taken from the processing firm by the food chain decreased from the normal level of purchases, channel system cost increased significantly as the processing firm experienced a reduction in output but not a corresponding decrease in plant and delivery costs. A decrease in purchases by the food chain of 33 per cent increased channel system cost 43 per cent for an interim period until the processor could find additional outlets and increase output to the normal level.

Intracity Delivery Methods

8. For intracity delivery from ORIGIN₁ (within the market area), average cost per case was approximately the same (less than .0100 dollar difference) using either the 700-case trucks or the 300-case trucks. The similarity of costs was explained in general by the fact that the greater operating cost per mile for the larger trucks was offset by the greater distances traveled by the smaller trucks (the result of more routes since each truck had less capacity). And for both sizes of trucks average utilization of capacity was about the same. Among individual routes the greatest variation in average cost was caused by the degree of utilization of truck capacity. Both methods required the same number of drivers and trucks. However, the 700-case trucks required a 3.84 greater capital investment.

9. For delivery from ORIGIN₂ (112 miles from the market area) the lowest cost method required one-two drivers to shuttle trucks from the egg plant to designated stores in the outlying fringes of the market area. From these stores other drivers delivered eggs to stores in the market area. This method required drivers to reside in both areas --near the plant and in the market area. The acceptability of this method for a distant egg firm would be dependent upon the potential use of drivers in the market area if trading relations with the food chain were terminated.

Union restrictions could also be a crucial factor. Compared to other methods of delivery from this location, this method had a cost advantage of .0600 to .1800 dollar per case. And relative to other methods using 700-case trucks the investment required was smaller.

10. From $ORIGIN_2$ the use of 300-case trucks resulted in an average cost per case which was .1100 dollar lower than the cost of using the 700-case trucks. The cost advantage of the smaller trucks resulted from the better utilization of truck capacity. Approximately 85 per cent of the capacity of the smaller trucks was utilized compared to 37 per cent for the 700-case trucks. Because of less capacity of the 700-case trucks being used per route, the same number of total routes were needed for both sizes of trucks. Consequently total miles in each method were about equal. This tended to increase the cost of the 700-case trucks because of their higher operating cost per mile.

11. A firm located within the market area had an important advantage in terms of lower cost direct delivery relative to a more distant firm. Between $ORIGIN_1$ and $ORIGIN_2$ delivery methods, there were significant cost, driver and capital investment differences. The comparable 300-case truck method of delivery had a 2.5 greater average cost and required twice as many trucks and drivers than its counterpart at $ORIGIN_1$. In general, increasing the distance from the major market area increased direct

delivery costs, drivers required, investment cost, and reduced the potential for using truck and labor resources in assembly operations.

12. Direct delivery to stores in an urban market was found to be more costly than line-hauling to a point within the market. More specifically, direct delivery from $ORIGIN_1$ or any given point outside the market area costs more per case than did line-hauling from the same point to $ORIGIN_1$. At a point 10 miles from the market ($ORIGIN_1$) direct delivery cost .1700 dollar per case more than line-hauling to $ORIGIN_1$. The difference was .2925 dollar at 110 miles and .4200 dollar at 230 miles.

13. The analysis of alternative intracity delivery methods demonstrated the factors which affect delivery cost--distance, volume, truck size, time, and utilization of truck capacity. The comparative advantage that firms in close proximity to market areas have in direct delivery over more distant firms was identified. While in a general way, such advantage may be obvious, firms with the potential for direct delivery must be able to evaluate cost-revenue relationships. For an egg firm at a given location from its major market area, the cost of direct delivery and the effect of direct delivery upon total truck and labor resources must be evaluated in view of potential revenues from direct delivery versus the costs and revenues from other delivery methods such as line-hauling.

ImplicationsChannel Systems

This analysis has shown that a large-scale independent channel system can operate at the same level of distribution costs as an integrated channel system. But for the independent channel system to maintain this competitive position with the integrated channel, firms in the channel must closely coordinate the flow of eggs. For this to occur a fairly stable trading relation must be developed between channel firms. This implies that there must be advantages for all firms in order for a channel system to be implemented. For egg firms such advantages of close coordination include less costly sales efforts, more efficient delivery and assembly operations and better utilization of plant capacity. For major buyers such as food chains the advantages of continuous large volumes of eggs include less costly purchasing and acquisition activities.

The issue of independent channel systems and the willingness of firms to develop together such systems raises two important considerations. One is how the advantages and benefits of close coordination are distributed among channel firms. It would appear that a mutual agreement as to how benefits are distributed would increase the workability of a channel system. To reach such an agreement, channel firms would need to be able to evaluate

their distribution costs. Such an evaluation would have to be made both in the context of the firm operating in a channel system and operating in channels which are uncoordinated. This evaluation would provide some insight as to the trade-offs between compromising the desired level of benefits in a channel system and a potentially lower level of benefits outside the channel system. In the overall willingness of firms to develop channel systems, bargaining power is a crucial factor. Since the food chains and other major buyers tend to enjoy the greater bargaining power relative to egg firms, a major element in determining the development of channel systems over time is the willingness of these buyers to engage in more closely coordinated channel systems. For these buyers the trade-offs between initiating ongoing channel systems with efficient suppliers and the changing of suppliers in response to potentially better terms of trade have to be considered. The second consideration for channel systems is how the channel firms are linked together. More specifically, there is a need for some way other than verbal agreement to spell out the relationship between egg firms and their suppliers. For example, written contracts which indicate the duration of the arrangement between an egg firm and a food chain would provide both firms with stability of egg flow for the period. There is a need for detailed analysis of alternative means for

defining relationships between channel firms. Closely related to this is the possible violation of laws governing inter-firm relationships by firms in closely coordinated channel systems. The issue of channel systems raises a number of questions relative to the legality of alternative means for linking channel firms.

The competitiveness of a large-scale integrated channel system and a similar independent channel system suggests that from the standpoint of distribution costs these channels are preferable to smaller less coordinated channels. In an operational efficiency sense the large-scale integrated and independent channel systems are more efficient in moving eggs from point of processing to retail stores. But in a pricing efficiency context the vagaries of retail pricing methods preclude any judgment about the desirability of the integrated channel versus the independent channel. The smaller independent channels in which distribution is more costly and consumer prices higher cannot be expected to dissipate in favor of larger channel systems. As long as consumers continue to utilize such outlets by choice or due to lack of other alternatives, these channels are a necessary part of the total egg distribution system. However, for these smaller channels, there is sufficient need for improving their operational efficiency in moving eggs from processing to retail points.

Food Chains

For food chains not integrated into egg processing the decision whether or not to do so is affected by a number of factors. It has been shown in this analysis that independent and integrated channel systems can be competitive in terms of the criterion of distribution cost. Intra-company transfer is not costless. The integrated firm has not eliminated all expenses of purchase-sale transactions. This implies that a major advantage of integrating into egg processing for the food chain is the economies arising from the improved coordination of the rate, amount, and quality of egg flow. To a high degree, these economies can be obtained without integration via ownership if there are large-scale egg suppliers in appropriate geographic locations to establish trading relations with. But herein lies the crux of the problem facing food chains. The unavailability of suppliers who can provide large continuous volumes of quality eggs creates pressures for integration. The capital investment required for egg procurement and processing facilities has to be evaluated relative to the benefits from integration into processing. Higher returning investment alternatives for the food chain likely exist.

For the integrated food chain in this analysis it was shown that a feasible alternative of direct delivery exists. An alternative direct delivery method was found

to be approximately the same cost as the firm's present system. In addition, the advantages of faster and direct delivery would result if the alternative method were adopted. But the present egg operation functions smoothly. The present egg distribution system is integrated into the food chain's total distribution warehouse operation and this tends to restrict the flexibility for change. The egg operation is a component of the larger system. As such the importance of designing the egg operation optimally as a single system is not as great as designing it so that the larger system operates at an acceptable level of efficiency. The advantages of faster and direct delivery are not as great when viewed from the total distribution system framework. Priorities are given to the larger system. The integrated firm is somewhat locked into the present egg distribution operation. Unlike the independent food chain, the integrated firm has to absorb increases in distribution cost. Both tradition and the share of warehousing costs borne by eggs in the present system tend to decrease the potential for change. Contrary to what is often assumed, a large integrated firm such as the food chain may not possess the flexibility for adjusting to changes in internal operations which offer advantages in a single-component context.

Egg Processors

For independent processors the ability for planning and implementing intracity delivery which is efficient in the sense of utilizing labor and truck resources is related to their degree of stability in trading relations with buyers. Furthermore, for the independent firm the ability to evaluate costs of alternative delivery methods increases its capability for negotiating prices with buyers which cover delivery costs. The knowledge of costs and the ability to plan delivery methods places the firm in a better position to improve the operational efficiency of delivery and similarly to integrate delivery and assembly functions. Potential for utilizing resources in both assembly and delivery can be increased if the firm can develop delivery systems which are fairly continuous through time and if deliveries can be made at night.

From the standpoint of bargaining power of the firm--its ability to negotiate prices which cover all costs and return satisfactory profits--the need for accurate cost data is apparent. If the firm cannot always negotiate such prices, the need for operationally efficient delivery is even more important. If buyers force the firm to make concessions in terms of delivery points (warehouse versus store door) which are not fully reflected in price differentials, with proper cost information the firm is in a position to identify the least-cost delivery method.

Initiation of direct delivery for firms may provide a greater profit margin for the firm but, depending upon the distance from buyers, these methods can increase the necessary investment in trucks for both delivery and assembly. In general, the type of delivery methods initiated needs to be evaluated in terms of the firm's total operation. But unlike the integrated food chain, the independent processor has fewer internal factors to consider in the context of planning the egg distribution operation. There likely is greater flexibility for change.

Intermediary Firms

To remain viable, intermediary firms such as wholesale distributors must perform functions such as sales to urban buyers and intracity delivery more efficiently than egg processors. In this analysis, large-scale wholesale distributors were required due to factors such as distance and market contacts which reduced the feasibility of direct delivery by more distant processors. Even if channel systems employing wholesale distributors have greater costs than more direct channels these channel systems may be necessary, given geographic locations of production and processing activities. While large-scale integrated production-marketing firms designed to serve local markets may increase, there will still be surplus and deficit regions. There will continue to be local and long-distance marketing systems.

For smaller volume buyers in urban areas the need for wholesale distributors is more apparent. The brief comparison of costs between large-scale channel systems and smaller channels suggested the higher cost of distributing eggs to smaller outlets. But such higher cost channel systems are required particularly if consumers continue to purchase from small retail outlets and the trend in increased institutional uses continues.

For intermediary firms the ability for planning and evaluating egg delivery methods and costs is no less relevant. Due to the types and size of buyers intermediary firms may not require the rigorous determination of feasible delivery methods but the use of cost data in a simple decision framework may improve operational efficiency.

Future Trends

This analysis was focused on the increasing size and coordination of firms in the fresh shell market egg industry. Changes in product technology were not considered. However, future changes in product form could have significant impact upon distribution structure. With changes in product form to frozen and packaged eggs and consumer acceptance of these fresh shell egg substitutes the structure of egg distribution could change significantly. The importance of moving fresh shell eggs quickly through the marketing channel would lessen. The need for specialized egg firms beyond the production and processing stages

would decrease. For food chains integrated into production and processing, additional investments would be needed to adopt the new technology required for converting fresh shell eggs into processed form. Furthermore, it is likely that the elimination of egg quality problems in marketing channels would reduce significantly the advantage of vertical integration by food chains into production and processing assuming that specialized egg processing firms gear up to handle new product changes. If a comparable trend in egg consumption develops in take-out prepared egg products as in the broiler industry, this too might affect the structure of distribution.¹

Needed Research

This study suggests that an important area for future research is the alternative ways for linking firms together in channel systems. This area of research would encompass such things as types of contractual arrangements between egg firms and buyers, the legality of alternative contractual arrangements, and the distribution of benefits among firms.

In this study a number of cost variables were difficult to obtain. Some of these related to instability in trading relationships between firms. For example, the

¹The development of fried chicken specialty foods as characterized by the Kentucky Fried Chicken franchises is a point of emphasis.

costs associated with concessions that egg suppliers give to buyers, inventory balancing costs, and the sales costs for suppliers selling to individual food stores were not determined in this study. Research to develop information about these cost variables would be desirable.

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APPENDICES

APPENDIX A

LOCKSET INPUT DATA AND ROUTES DEFINED BY
LOCKSET ANALYSIS FOR EACH INTRACITY
DELIVERY METHOD

EXHIBIT A-1.--Stores, volume, and stop time.

***** DELIVERY STOP *****	***** LOAD WT. AND CUBE *****	***** TYPE *****	***** STOPTIME *****	
415	2	25	1	160
457	3	38	1	230
395	4	25	1	160
443	5	12	1	165
346	6	25	1	160
335	7	25	1	160
388	8	25	1	160
148	9	25	1	165
910	10	12	1	160
312	11	25	1	160
412	12	25	1	160
284	13	25	1	160
356	14	25	1	230
287	15	38	1	160
358	16	25	1	160
441	17	25	1	160
375	18	25	1	160
267	19	25	1	160
184	20	25	1	160
916	21	25	1	160
323	22	25	1	160
248	23	25	1	160
322	24	25	1	160
263	25	25	1	160
355	26	25	1	160
290	27	25	1	160
399	28	25	1	160
315	29	25	1	160
463	30	25	1	160
282	31	25	1	160
318	32	25	1	160
920	33	25	1	160
367	34	25	1	160
919	35	25	1	160
900	36	25	1	160
310	37	25	1	165
273	38	12	1	160
434	39	25	1	160
308	40	25	1	230
360	41	38	1	165
324	42	12	1	160
909	43	25	1	230
915	44	38	1	160
331	45	25	1	165
371	46	12	1	160
283	47	25	1	

EXHIBIT A-1.--continued.

452	48	38	1	1	230
343	49	38	1	1	230
351	50	25	1	1	160
376	51	25	1	1	160
442	52	25	1	1	160
392	53	25	1	1	160
923	54	25	1	1	160
269	55	25	1	1	160
379	56	25	1	1	160
341	57	38	1	1	230
435	58	12	1	1	165
297	59	25	1	1	160
902	60	25	1	1	160
271	61	25	1	1	160
391	62	25	1	1	160
398	63	25	1	1	160
382	64	38	1	1	230
926	65	25	1	1	160
905	66	25	1	1	160
288	67	25	1	1	160
313	68	12	1	1	165
370	69	25	1	1	160
917	70	25	1	1	160
433	71	25	1	1	160
420	72	12	1	1	165
906	73	25	1	1	160
TOTAL		1800			

EXHIBIT A-2.--Routes in IDS₁.

[illegible]

441	17	412	12	25	1	1	45	160
412	12	910	10	12	1	1	79	165
910	10	457	3	38	1	1	112	230
457	3	395	4	25	1	1	168	160
395	4	443	5	12	1	1	108	165
443	5	284	13	25	1	1	96	160
284	13	263	25	25	1	1	108	160
263	25	184	20	25	1	1	31	160
184	20	273	38	12	1	1	84	165
273	38	355	26	25	1	1	103	160
355	26	919	35	25	1	1	120	160
919	35	331	45	25	1	1	52	160
331	45	376	51	25	1	1	48	160
376	51	271	61	25	1	1	96	160
271	61	370	69	25	1	1	60	160
370	69	ORIGIN					132	
TOTAL FOR ROUTE.....								5998
								3835
								2163
								562
								23

700	99	ORIGIN	32	25	1	1	389	160
		318	32	25	1	1	252	160
		367	34	25	1	1	273	160
		335	7	25	1	1	391	160
		335	7	25	1	1	55	160
		388	8	25	1	1	67	160
		356	14	25	1	1	48	160
		267	19	25	1	1	96	230
		267	19	25	1	1	48	165
		399	28	38	1	1	160	160
		360	41	12	1	1	48	160
		371	46	25	1	1	120	160
		392	53	25	1	1	139	160
		398	63	25	1	1	151	160
		433	71	25	1	1	60	160
		905	66	25	1	1	45	165
		288	67	12	1	1	72	160
		420	72	25	1	1	120	160
		917	70	25	1	1	43	
		917	70	25	1	1		
		906	73	25	1	1		
		ORIGIN						
TOTAL FOR ROUTE.....								5329
								2800
								2529
								412
								17

ALL ROUTES..... 1800 72 8666 12120 20786

EXHIBIT A-3.--Routes in IDS₂.

CARRIER	MAX. WT.	CUBE	FROM	TO	LEAD WT.	CUBE	TYPE	TRAVEL	STOP TIME	TOTAL DISTANCE
CAR1	1	300	99	ORIGIN	13	25	1	472	160	
				284	5	12	1	96	165	
				443	4	25	1	108	160	
				395	3	38	1	168	230	
				457	10	12	1	112	165	
				910	12	25	1	79	160	
				412	17	25	1	45	160	
				441	24	25	1	36	160	
				322	18	25	1	62	160	
				375				455		
				ORIGIN						
				18						
				375						
				ORIGIN						
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				375			</			

EXHIBIT A-3.--Routes in IDS₂.

CARRIER	MAX. WT.	CUBE FROM	CUBE TO	LOAD WT.	CUBE	TYPE	TRAVEL	STOP TIME	TOTAL DISTANCE
---------	----------	-----------	---------	----------	------	------	--------	-----------	----------------

CAR1	1	300	99	ORIGIN	284	13	25	1	1	472	160	
					443	5	12	1	1	96	165	
					395	4	25	1	1	108	160	
					457	3	38	1	1	168	230	
					910	10	12	1	1	112	165	
					412	12	25	1	1	79	160	
					441	17	25	1	1	45	160	
					322	24	25	1	1	36	160	
					375	18	25	1	1	62	160	
					ORIGIN					455		
TOTAL FOR ROUTE.....										1633	1520	3153

CAR2	1	300	99	ORIGIN	358	16	25	1	1	574	160	
					323	22	25	1	1	33	160	
					343	49	38	1	1	170	230	
					463	30	25	1	1	120	160	
					315	29	25	1	1	153	160	
					308	40	25	1	1	96	160	
					310	37	25	1	1	105	160	
					ORIGIN					376		
TOTAL FOR ROUTE.....										1627	1190	2817

CAR3	1	300	99	ORIGIN	324	42	12	1	1	348	160	
					290	27	25	1	1	91	160	
					916	21	25	1	1	160	160	
					287	15	38	1	1	40	230	
					312	11	25	1	1	14	160	
					148	9	25	1	1	16	160	
					415	2	25	1	1	181	160	
					346	6	25	1	1	199	160	
					351	50	25	1	1	252	160	
					ORIGIN					288		
TOTAL FOR ROUTE.....										1569	1515	3154

CAR4	1	300	99	ORIGIN	376	51	25	1	1	288	160
					331	45	25	1	1	48	160
					919	35	25	1	1	52	160
					355	26	25	1	1	120	160
					263	25	25	1	1	144	160
					184	20	25	1	1	31	160
					273	38	12	1	1	84	165
					915	44	38	1	1	79	230
					283	47	25	1	1	46	160

283 47 909 43 25 1 1 60 160
 909 43 923 54 25 1 1 96 160
 923 54 ORIGIN 271
 TOTAL FOR ROUTE..... 275 11 1309 1035 3144

CAR5 1 300 99 ORIGIN 371 46 371 46 12 1 1 322 160
 371 46 360 41 38 1 1 48 230
 360 41 399 28 25 1 1 96 160
 399 28 267 19 25 1 1 67 160
 267 19 356 14 25 1 1 55 160
 356 14 388 8 25 1 1 391 160
 388 8 335 7 25 1 1 273 160
 335 7 367 34 25 1 1 165 160
 367 34 398 63 25 1 1 172 160
 398 63 ORIGIN 1537 1515
 TOTAL FOR ROUTE..... 225 9 1537 1515 4152

CAR6 1 300 99 ORIGIN 313 68 313 68 12 1 1 144 160
 313 68 442 52 25 1 1 180 160
 442 52 434 39 25 1 1 84 160
 434 39 248 23 25 1 1 79 160
 248 23 282 31 25 1 1 67 160
 282 31 920 33 25 1 1 79 160
 920 33 452 48 38 1 1 79 160
 452 48 269 55 25 1 1 46 160
 269 55 271 61 25 1 1 96 160
 271 61 370 69 25 1 1 60 160
 370 69 917 70 25 1 1 132 160
 917 70 ORIGIN 120
 TOTAL FOR ROUTE..... 275 11 1169 1835 4523

CAR7 1 300 99 ORIGIN 926 65 926 65 25 1 1 156 160
 926 65 382 64 38 1 1 36 230
 382 64 391 62 25 1 1 37 160
 391 62 902 60 25 1 1 42 160
 902 60 900 36 25 1 1 180 160
 900 36 379 56 25 1 1 151 160
 379 56 341 57 38 1 1 38 230
 341 57 435 58 12 1 1 15 160
 435 58 297 59 25 1 1 39 160
 297 59 905 66 25 1 1 51 160
 905 66 288 67 25 1 1 60 160
 288 67 420 72 12 1 1 45 160
 420 72 ORIGIN 103
 TOTAL FOR ROUTE..... 300 12 953 2070 3023

CAR8 1 300 99 ORIGIN 318 32 318 32 25 1 1 389 160
 318 32 392 53 25 1 1 277 160

R82

392	53	433	71	25	1	1	259	160
433	71	906	73	25	1	1	64	160
906	73	ORIGIN					43	
TOTAL FOR ROUTE.....				100	4		1052	640
								1692
ROUTES.....				1800	72		10968	12120
								23088

EXHIBIT A-4.--Routes in IDS₃.

TRUCK NO.1 CAPACITY 700 CASES

ROUTE NO. 1 - MONDAY-WEDNESDAY-FRIDAY

CUSTOMER NO.	ORDER SIZE	TRAVEL TIME	STOP TIME
COLDWATER			
368	25	125.5	16
335	25	37.1	16
367	25	27.3	16
318	25	25.2	16
356	25	26.8	16
COLDWATER		128.2	

TOTAL LOAD..... 125

TOTAL TIME..... 372.1 80 452.1

TRUCK NO.2 CAPACITY 700 CASES

ROUTE NO. 2 - MONDAY-WEDNESDAY-FRIDAY

CUSTOMER NO.	ORDER SIZE	TRAVEL TIME	STOP TIME
COLDWATER			
267	25	131.8	16
359	25	4.8	16
360	38	9.6	23
371	12	4.8	16
905	25	17.1	16
288	25	6.0	16
297	25	6.0	16
435	12	3.9	16
346	25	38.2	16
415	25	19.9	16
148	25	18.1	16
312	25	1.0	16
287	38	1.4	23
916	25	4.0	16
290	25	16.0	16
900	25	15.1	16
324	12	12.0	16
351	25	7.9	16
COLDWATER		171.9	

TOTAL LOAD..... 437

TOTAL TIME..... 490.1 302 792.1

EXHIBIT A-4.--continued.

TRUCK NO. 3 CAPACITY 700 CASES

ROUTE NO. 3 - MONDAY-WEDNESDAY-FRIDAY

CUSTOMER NO.	ORDER SIZE	TRAVEL TIME	STOP TIME
283	25	178.2	16
915	38	3.6	23
273	12	7.9	16
184	25	8.4	16
263	25	3.1	16
284	25	10.8	16
443	12	9.6	16
323	25	24.4	16
358	25	3.3	16
457	38	24.0	23
395	25	16.8	16
910	12	9.1	16
355	25	7.2	16
909	25	9.6	16
379	25	17.9	16
341	38	3.8	23
COLDWATER		170.1	

TOTAL LOAD..... 400

TOTAL TIME..... 507.8 277 764.8

TRUCK NO. 1 CAPACITY 700 CASES

ROUTE NO. 4 - TUESDAY-THURSDAY-SATURDAY

CUSTOMER NO.	ORDER SIZE	TRAVEL TIME	STOP TIME
310	25	221.5	16
343	25	16.2	16
308	38	5.7	23
315	25	9.6	16
463	25	15.3	16
248	25	14.4	16
434	25	7.9	16
442	25	8.4	16
282	25	10.8	16
375	25	6.2	16
322	25	6.2	16
920	25	4.3	16
441	25	7.9	16
412	25	4.5	16
919	25	9.6	16
COLDWATER		193.8	

TOTAL LOAD..... 388

TOTAL TIME..... 542.3 247 789.3

EXHIBIT A-4.--continued.

TRUCK NO. 2 CAPACITY 700 CASES
 ROUTE NO. 5 TUESDAY-THURSDAY-SATURDAY

CUSTOMER NO.	ORDER SIZE	TRAVEL TIME	STOP TIME
*****	*****	*****	****
COLDWATER			
433	25	174.7	16
906	25	6.4	16
398	25	12.9	16
392	25	12.0	16
313	12	18.2	16
370	25	4.9	16
271	25	6.0	16
269	25	9.6	16
452	38	4.8	23
331	25	11.5	16
376	25	4.3	16
923	25	12.2	16
902	25	7.9	16
391	25	4.2	16
382	38	3.7	23
926	25	3.6	16
917	25	9.1	16
420	12	7.2	16
COLDWATER		170.1	

TOTAL LOAD.....	450		
TOTAL TIME.....	463.8	302	785.8
TOTAL ALL ROUTES...	1800	2395.1	1208 3604.1

EXHIBIT A-5.--Routes in IDS₄.

BY LEONARD W. SCHROEN 5-25-70

TRUCK NO.1 CAPACITY 300 CASES
ROUTE NO.1 MONDAY-WEDNESDAY-FRIDAY

*****	*****	*****	****
CUSTOMER	ORDER SIZE	TRAVEL	STOP
NO.		TIME	TIME
*****	*****	*****	****
COLDWATER			
288	25	165.6	16
420	12	4.5	16
517	25	7.2	16
382	38	12.7	23
391	25	3.7	16
502	25	4.2	16
923	25	7.9	16
909	25	9.6	16
283	25	6.0	16
379	25	11.9	16
341	38	3.8	24
COLDWATER		170.1	
	-----	-----	-----
TOTAL LOAD	288	407.2	190
TOTAL TIME			597.2

TRUCK NO.2 CAPACITY 300 CASES
ROUTE NO.2 MONDAY-WEDNESDAY-FRIDAY

*****	*****	*****	****
CUSTOMER	ORDER SIZE	TRAVEL	STOP
NO.		TIME	TIME
*****	*****	*****	****
COLDWATER			
310	25	221.5	16
343	38	16.2	23
308	25	5.7	16
315	25	9.6	16
463	25	15.3	16
248	25	14.4	16
434	25	7.9	16
442	25	8.4	16
313	12	18.0	16
470	25	4.9	16
271	25	6.0	16
526	25	10.6	16
COLDWATER		179.2	
	-----	-----	-----
TOTAL LOAD	300	518.5	199
TOTAL TIME			717.5

TRUCK NO.3 CAPACITY 300 CASES
ROUTE NO.3 MONDAY-WEDNESDAY-FRIDAY

*****	*****	*****	****
CUSTOMER	ORDER SIZE	TRAVEL	STOP

EXHIBIT A-5.--continued.

NO.	*****	TIME	TIME	
*****	*****	*****	****	
COLDWATER				
318	25	153.1	16	
367	25	25.2	16	
335	25	27.3	16	
392	25	27.1	16	
398	25	12.0	16	
906	25	12.9	16	
433	25	6.4	16	
905	25	15.1	16	
371	12	17.1	16	
360	38	4.8	23	
399	25	9.6	16	
267	25	4.8	16	
COLDWATER		131.8		
	-----	-----	-----	
TOTAL LOAD	300			
TOTAL TIME		447.2	199	646.2

TRUCK NO.4 CAPACITY 300 CASES
ROUTE NO.4 MONDAY-WEDNESDAY-FRIDAY

*****	*****	*****	****	
*****	*****	*****	****	
CUSTOMER	ORDER SIZE	TRAVEL	STOP	
NO.		TIME	TIME	
*****	*****	*****	****	
COLDWATER				
346	25	197.1	16	
415	25	17.9	16	
148	25	18.1	16	
312	25	1.5	16	
287	38	1.4	23	
916	25	4.0	16	
290	25	16.0	16	
900	25	15.1	16	
324	12	12.0	16	
351	25	7.9	16	
297	25	9.1	16	
COLDWATER		164.7		
	-----	-----	-----	
TOTAL LOAD	275			
TOTAL TIME		466.9	133	649.9

TRUCK NO.1 CAPACITY 300 CASES
ROUTE NO.5 TUESDAY-THURSDAY-SATURDAY

*****	*****	*****	****	
*****	*****	*****	****	
CUSTOMER	ORDER SIZE	TRAVEL	STOP	
NO.		TIME	TIME	
*****	*****	*****	****	
COLDWATER				
376	25	190.9	16	
331	25	4.8	16	
919	25	5.2	16	
412	25	9.6	16	
441	25	4.5	16	
920	25	7.9	16	
322	25	4.3	16	
375	25	6.2	16	

EXHIBIT A-5.--continued.

282	25	6.2	16	
452	38	9.1	23	
269	25	4.8	16	
CCLWATER		193.3		
	-----	-----	-----	
TOTAL LOAD	288			
TOTAL TIME		446.8	183	629.8

TRUCK NO. 2 CAPACITY 300 CASES

ROUTE NO. 6 TUESDAY-THURSDAY-SATURDAY

*****	*****	*****	****
CUSTOMER	ORDER SIZE	TRAVEL	STOP
NO.		TIME	TIME
*****	*****	*****	****
CCLWATER			
435	12	168.6	15
915	38	13.2	23
273	12	7.9	16
184	25	8.4	16
263	25	3.1	16
284	25	10.8	16
443	12	9.6	16
323	25	24.4	16
353	25	3.3	16
457	38	24.0	23
395	25	16.8	16
910	12	9.1	16
355	25	7.2	16
CCLWATER		190.2	

TOTAL LOAD	295			
TOTAL TIME		498.6	222	713.6

TRUCK NO. 3 CAPACITY 300 CASES

ROUTE NO. 7 TUESDAY-THURSDAY-SATURDAY

*****	*****	*****	****
CUSTOMER	ORDER SIZE	TRAVEL	STOP
NO.		TIME	TIME
*****	*****	*****	****
CCLWATER			
356	25	128.2	16
388	25	5.5	16
CCLWATER		125.5	

TOTAL LOAD	50			
TOTAL TIME		259.2	32	291.2

TOTAL ALL ROUTES	1800	3042.4	1208	4250.4
------------------	------	--------	------	--------

EXHIBIT A-6.--Routes in IDS₅.

TRUCK NO.1 CAPACITY 700 CASES,15.20 MIN.
ROUTE NO. 1 MONDAY-WEDNESDAY-FRIDAY

CUSTOMER NO.	ORDER SIZE	TRAVEL TIME	STOP TIME
*****	*****	*****	****
COLDWATER	*****	*****	****
283	25	178.2	16
915	38	3.6	23
273	12	7.9	16
184	25	8.4	16
263	25	3.1	16
284	25	10.8	16
443	12	9.6	16
323	25	24.4	16
358	25	3.3	16
457	38	24.0	23
395	25	16.8	16
910	12	9.1	16
355	25	7.2	16
909	25	9.6	16
379	25	17.9	16
341	38	3.8	23
435	12	1.5	16
297	25	3.9	16
COLDWATER		164.7	
---	---	-----	---
TOTAL LOAD.....437			
TOTAL TIME.....		507.8	309 816.8

TRUCK NO.2 CAPACITY 700 CASES,15.20 MIN.
ROUTE NO. 2 MONDAY-WEDNESDAY-FRIDAY

CUSTOMER NO.	ORDER SIZE	TRAVEL TIME	STOP TIME
*****	*****	*****	****
COLDWATER	*****	*****	****
310	25	221.5	16
143	38	16.2	23
308	25	5.7	16
315	25	9.6	16
463	25	15.3	16
248	25	14.4	16
434	25	7.9	16
442	25	8.4	16
282	25	10.8	16
375	25	6.2	16
322	25	6.2	16
920	25	4.3	16
441	25	7.9	16
412	25	4.5	16

EXHIBIT A-6.--continued.

919	25	9.6	16
331	25	5.2	16
452	38	11.5	23
269	25	4.8	16
376	25	9.1	16
923	25	12.2	16
COLDWATER		190.2	
	---	-----	---
TOTAL LOAD.....526			
TOTAL TIME.....		581.5	334 915.5

TRUCK NO.1 CAPACITY 700 CASES,15.20 MIN.
ROUTE NO. 3 TUESDAY-THURSDAY-SATURDAY

CUSTOMER NO.	***** ORDER SIZE *****	***** TRAVEL TIME *****	**** STOP TIME ****
COLDWATER			
346	25	197.1	16
415	25	19.9	16
148	25	18.1	16
312	25	1.6	16
287	38	1.4	23
916	25	4.0	16
290	25	16.0	16
900	25	15.1	16
324	12	12.0	16
351	25	7.9	16
267	25	44.5	16
356	25	6.7	16
388	25	5.5	16
COLDWATER		125.5	
	---	-----	---
TOTAL LOAD.....325			
TOTAL TIME.....		475.3	215 690.3

EXHIBIT A-6.--continued.

TRUCK NO.2 CAPACITY 700 CASES,15.20 MIN.

ROUTE NO. 4 TUESDAY-THURSDAY-SATURDAY

CUSTOMER

ORDER SIZE

TRAVEL

STOP

NO.

TIME

TIME

CCLDWATER

399

25

134.5

16

360

38

9.6

23

371

12

4.8

16

905

25

17.1

16

433

25

15.1

16

906

25

6.4

16

398

25

12.9

16

392

25

12.0

16

313

12

18.2

16

370

25

4.9

16

271

25

6.0

16

382

38

7.2

23

391

25

3.7

16

902

25

4.2

16

926

25

10.2

16

917

25

9.1

16

420

12

7.2

16

288

25

4.5

16

335

25

64.2

16

367

25

27.3

16

318

25

25.2

16

CCLDWATER

153.1

TOTAL LOAD.....512

TOTAL TIME.....557.4 350 907.4

EXHIBIT A-7.--Routes in IDS₆.

BY LEONARD W. SCHROEN 6-10-75

TRUCK NO. 1 CAPACITY 300 CASES, 675 MINUTES MAXIMUM TRIP TIME
 ROUTE NO. 1 MONDAY-WEDNESDAY-FRIDAY

CUSTOMER NO.	ORDER SIZE	TRAVEL TIME	STOP TIME
*****	*****	*****	****
COLDWATER			
184	25	148.1	16
263	25	3.1	16
284	25	10.8	16
443	12	5.6	16
323	25	24.4	16
358	25	3.3	16
457	38	24.0	23
355	25	16.8	16
910	12	9.1	26
355	25	7.2	16
COLDWATER		140.2	

TOTAL LOAD.....237

TOTAL TIME.....496.6 167 663.0

TRUCK NO. 2 CAPACITY 300 CASES, 675 MINUTES MAXIMUM TRIP TIME
 ROUTE NO. 2 MONDAY-WEDNESDAY-FRIDAY

CUSTOMER NO.	ORDER SIZE	TRAVEL TIME	STOP TIME
*****	*****	*****	****
COLDWATER			
267	25	131.2	16
359	25	4.8	16
356	25	8.4	16
367	25	52.0	16
318	25	25.2	16
368	25	27.6	16
COLDWATER		125.5	

TOTAL LOAD.....150

TOTAL TIME.....375.3 96 471.3

TRUCK NO. 3 CAPACITY 300 CASES, 675 MINUTES MAXIMUM TRIP TIME
 ROUTE NO. 3 MONDAY-WEDNESDAY-FRIDAY

CUSTOMER NO.	ORDER SIZE	TRAVEL TIME	STOP TIME
*****	*****	*****	****
COLDWATER			
310	25	221.5	16
343	38	16.2	23
308	25	5.7	16
315	25	9.6	16

EXHIBIT A-7.--continued.

463	25	15.3	16
248	25	14.4	16
434	25	7.9	16
442	25	8.4	16
313	12	18.0	16
COLDWATER		194.7	
---		---	---
TOTAL LOAD.....225			
TOTAL TIME.....511.7		151	662.7

TRUCK NO. 4 CAPACITY 300 CASES, 675 MINUTES MAXIMUM TRIP TIME
 ROUTE NO. 4 MONDAY-WEDNESDAY-FRIDAY

*****	*****	*****	****
CUSTOMER	ORDER SIZE	TRAVEL	STOP
NO.		TIME	TIME
*****	*****	*****	****
COLDWATER			
375	25	154.6	16
392	25	27.1	16
398	25	12.0	16
906	25	12.9	16
423	25	6.4	16
420	12	6.7	16
917	25	7.2	16
288	25	11.5	16
341	30	11.4	23
379	25	3.8	16
297	25	9.2	16
905	25	5.1	16
COLDWATER		159.6	
---		---	---
TOTAL LOAD.....300			
TOTAL TIME.....437.5		199	636.5

TRUCK NO. 1 CAPACITY 300 CASES, 675 MINUTES MAXIMUM TRIP TIME
 ROUTE NO. 5 TUESDAY-THURSDAY-SATURDAY

*****	*****	*****	****
NO.		TIME	TIME
*****	*****	*****	****
COLDWATER			
346	25	197.1	16
419	25	19.9	16
148	25	18.1	16
312	25	1.6	16
297	38	1.4	23
916	25	4.0	16
290	25	16.0	16
900	25	15.1	16
324	12	12.0	16
351	25	7.9	16
360	38	34.2	23
COLDWATER		139.8	
---		---	---
TOTAL LOAD.....288			
TOTAL TIME.....467.1		190	557.1

EXHIBIT A-7.--continued.

TRUCK NO. 2 CAPACITY 300 CASES, 675 MINUTES MAXIMUM TRIP TIME

ROUTE NO. 6 TUESDAY-THURSDAY-SATURDAY

*****	*****	*****	****
NO.		TIME	TIME
*****	*****	*****	****
COLDWATER			
371	12	142.5	16
526	25	37.3	16
271	25	10.8	16
370	25	6.0	16
382	38	6.4	23
391	25	3.7	16
502	25	4.2	16
523	25	7.9	16
509	25	5.6	16
273	12	17.0	16
515	38	7.9	23
283	25	3.6	16
COLDWATER		178.2	

TOTAL LOAD.....300

TOTAL TIME.....435.1 206 641.1

TRUCK NO. 3 CAPACITY 300 CASES, 675 MINUTES MAXIMUM TRIP TIME

ROUTE NO. 7 TUESDAY-THURSDAY-SATURDAY

*****	*****	*****	****
NO.		TIME	TIME
*****	*****	*****	****
COLDWATER			
435	12	165.6	16
376	25	22.3	16
371	25	4.8	16
519	25	5.2	16
412	25	9.6	16
441	25	4.5	16
520	25	7.5	16
322	25	4.3	16
375	25	6.2	16
282	25	6.2	16
452	38	9.1	23
269	25	4.8	16
COLDWATER		193.3	

TOTAL LOAD.....300

TOTAL TIME.....446.8 199 645.8

EXHIBIT A-8.--Routes in IDS₇.

BY LEONARD W. SCHRUBEN 6-10-70

TRUCK NO. 1 CAPACITY 700 CASES, 675 MINUTES MAXIMUM TRIP TIME
 ROUTE NO. 1 MCNCAY-WEDNESDAY-FRIDAY

CUSTOMER NO.	ORDER SIZE	TRAVEL TIME	STOP TIME
COLDWATER			
184	25	198.1	16
263	25	3.1	16
284	25	10.8	16
443	12	9.6	16
323	25	24.4	16
358	25	3.3	16
457	38	24.0	23
395	25	16.8	16
910	12	9.1	16
355	25	7.2	16
COLDWATER		190.2	
TOTAL LOAD.....237			
TOTAL TIME.....496.6		167	663.6

TRUCK NO. 2 CAPACITY 700 CASES, 675 MINUTES MAXIMUM TRIP TIME
 ROUTE NO. 2 MCNCAY-WEDNESDAY-FRIDAY

CUSTOMER NO.	ORDER SIZE	TRAVEL TIME	STOP TIME
COLDWATER			
310	25	221.5	16
343	38	16.2	23
308	25	5.7	16
315	25	9.6	16
463	25	15.3	16
248	25	14.4	16
434	25	7.9	16
442	25	8.4	16
313	12	18.0	16
COLDWATER		194.7	
TOTAL LOAD.....225			
TOTAL TIME.....511.7		151	662.7

TRUCK NO. 3 CAPACITY 700 CASES, 675 MINUTES MAXIMUM TRIP TIME
 ROUTE NO. 3 MCNCAY-WEDNESDAY-FRIDAY

CUSTOMER NO.	ORDER SIZE	TRAVEL TIME	STOP TIME
COLDWATER			

EXHIBIT A-8.--continued.

346	25	197.1	16
415	25	19.4	16
148	25	18.1	16
312	25	1.6	16
287	38	1.4	23
916	25	4.0	16
290	25	16.0	16
900	25	15.1	16
324	12	12.0	16
351	25	7.9	16
297	25	9.1	16
905	25	5.1	16
COLDWATER		159.6	

TOTAL LOAD.....300			
TOTAL TIME.....466.9		199	665.9

TRUCK NO. 4 CAPACITY 700 CASES, 675 MINUTES MAXIMUM TRIP TIME
 ROUTE NO. 4 MONDAY-WEDNESDAY-FRIDAY

CUSTOMER NO.	ORDER SIZE	TRAVEL TIME	STOP TIME
*****	*****	*****	****
COLDWATER			
356	25	128.2	16
318	25	26.8	16
367	25	25.2	16
335	25	27.3	16
392	25	27.1	16
398	25	12.0	16
906	25	12.9	16
433	25	6.4	16
288	25	11.2	16
371	12	23.1	16
360	38	4.8	23
399	25	9.6	16
267	25	4.8	16
COLDWATER		131.8	

TOTAL LOAD.....325			
TOTAL TIME.....451.2		215	666.2

TRUCK NO. 1 CAPACITY 700 CASES, 675 MINUTES MAXIMUM TRIP TIME
 ROUTE NO. 5 TUESDAY-THURSDAY-SATURDAY

CUSTOMER NO.	ORDER SIZE	TRAVEL TIME	STOP TIME
*****	*****	*****	****
COLDWATER			
376	25	100.9	16
331	25	9.8	16
919	25	9.2	16
412	25	9.6	16
441	25	4.5	16
920	25	7.9	16
322	25	4.3	16
375	25	6.2	16
282	25	6.2	16

EXHIBIT A-8.--continued.

452	38	9.1	23
269	25	4.8	16
271	25	9.6	16
370	25	6.0	16
CCLDWATER		189.8	
---		----	---
TOTAL LOAD.....		338	
TOTAL TIME.....		458.9	215 673.9

TRUCK NO. 2 CAPACITY 700 CASES, 675 MINUTES MAXIMUM TRIP TIME
 ROUTE NO. 6 TUESDAY-THURSDAY-SATURDAY

*****	*****	*****	****
CUSTOMER	ORDER SIZE	TRAVEL	STOP
NO.		TIME	TIME
*****	*****	*****	****
COLDWATER			
388	25	125.5	16
CCLDWATER		125.5	
---		----	---
TOTAL LOAD.....		25	
TOTAL TIME.....		251.0	16 267.0

TRUCK NO. 3 CAPACITY 700 CASES, 675 MINUTES MAXIMUM TRIP TIME
 ROUTE NO. 7 TUESDAY-THURSDAY-SATURDAY

*****	*****	*****	****
CUSTOMER	ORDER SIZE	TRAVEL	STOP
NO.		TIME	TIME
*****	*****	*****	****
COLDWATER			
420	12	170.1	16
917	25	7.2	16
926	25	9.1	16
382	38	3.6	23
391	25	3.7	16
902	25	4.2	16
923	25	7.9	16
909	25	9.6	16
273	12	17.0	16
915	38	7.9	23
283	25	3.6	16
379	25	11.9	16
341	38	3.8	23
435	12	1.5	16
CCLDWATER		168.6	
---		----	---
TOTAL LOAD.....		350	
TOTAL TIME.....		429.7	245 674.7

APPENDIX B

DERIVATION OF TRUCK COSTS

TABLE B-1.--Equipment valuation and depreciation, tractor and refrigerated trailer.

Equipment	New Cost ^a	Salvage Value	Years to Depreciate	Annual Depreciation
	(dollars)	(dollars)	(years)	(dollars)
Tractor	18,100	1,000	7	2,443
Trailer	11,900	1,000	8	1,363
Refrigeration	5,500		6	917
Total	35,500			4,723

^aInflated by 6.0 per cent to be more representative of 1969 conditions.

Source: Orval L. Kerchner, Costs of Transporting Bulk and Packaged Milk by Truck, U.S. Department of Agriculture, Economic Research Service, MRR-791 (Washington, D.C.: Government Printing Office, 1967).

TABLE B-2.--Annual fixed costs for tractor and refrigerated trailer used in egg distribution.

Cost Item	Annual Cost
	(dollars)
Depreciation ^a	
Equipment	4,723
Building and tools (maintenance shop and office space)	300
Insurance ^b	1,100
Interest ^c	1,500
Federal highway-use tax ^d	200
License and miscellaneous tax	900
Management and office salaries ^e	1,155
Administrative costs	700
Total	10,578
Annual fixed cost per mile ^f	.1763 (60,000)

^aSee Table B-1 for method of depreciation.

^bInsurance cost inflated approximately 10.0 per cent over 1966 data.

^cComputed at 8.0 per cent on midlife value of equipment.

^dFederal highway-use tax, license and miscellaneous tax, and administrative costs inflated by 6.0 per cent over 1966 data. The inflator was the Wholesale Price Index of Motor Vehicles and Equipment.

^eInflated by 18.75 per cent over 1966 to account for increase in hourly wage rate for total private production and nonsupervisory nonagricultural workers between 1966 and July 1969. Supervision and clerical personnel plus a return to management.

^fAssuming 60,000 miles per year.

Source: Orval L. Kerchner, Costs of Transporting Bulk and Packaged Milk by Truck, U.S. Department of Agriculture, Economic Research Service, MRR-791 (Washington, D.C.: Government Printing Office, 1967).

TABLE B-3.--Variable operating cost per mile, tractor and refrigerated trailer.

Cost Item	Variable Operating Cost per Mile
	(dollars)
Fuel, diesel ^a	.0500
Tires	.0180
Maintenance	
Grease, oil	.0082
Repairs	.0160
Labor ^b	.0110
Miscellaneous	.0106
Refrigeration ^c	.0167
Total variable cost	.1305

^aFuel, tires, grease and oil, repairs, refrigeration and miscellaneous costs were inflated by 6 per cent. The inflator was the Wholesale Price Index of Motor Vehicles and Equipment.

^bLabor cost was inflated by 18.75 per cent to account for the increase in hourly wage rate for total private production and nonsupervisory, nonagricultural workers between 1966 and July 1969.

^cRefrigeration cost of .5500 dollars per hour. Per mile cost obtained by division by driving speed (40 mph).

Source: Orval L. Kerchner, Costs of Transporting Bulk and Packaged Milk by Truck, U.S. Department of Agriculture, Economic Research Service, MRR-791 (Washington, D.C.: Government Printing Office, 1967).



TABLE B-4.--Equipment valuation and depreciation, 300-case refrigerated truck.

Equipment	New Cost	Salvage Value	Years to Depreciate	Annual Depreciation
	(dollars)	(dollars)	(years)	(dollars)
Truck		2,945 ^a	4 ^b	1,576
Chassis	4,200			
Body	5,050			
Total	9,250			1,576

^aChassis was assumed to have salvage value of 10 per cent of original cost and the body of a salvage value of 50 per cent at the end of four years.

^bTwenty-five per cent per year of new cost less salvage value.

Source: John S. Hobson, "Optimum Number, Size, and Location of Egg Processing Plants in Indiana" (unpublished Master's thesis, Purdue University, 1968).

TABLE B-5.--Annual fixed costs for 300-case straight truck, refrigerated.

Cost Item	Annual Cost
	(dollars)
Depreciation ^a	1,576
Interest ^b	488
License	350
Insurance	500
Management, office, and administrative costs ^c	1,050
Total	3,964
Annual fixed cost per mile ^d	.0660

^aSee Table B-4.

^bComputed at 8.0 per cent on midlife value of equipment.

^cBased on Costs of Operating Exempt For-Hire Motor Carriers of Agricultural Commodities, A Pilot Study in Delaware, Maryland and Virginia, ERS 109, ERS-USDA, 1960.

^dAssuming 60,000 miles per year.

Source: Data adopted from J. S. Hobson, "Optimum Number, Size, and Location of Egg Processing Plants in Indiana" (unpublished Master's thesis, Purdue University, 1968).

TABLE B-6.--Variable operating cost per mile for 300-case refrigerated truck.

Cost Item	Variable Operating Cost per Mile
	(dollars)
Gasoline ^a	.0520
Oil, grease	.0060
Tires	.0550
Miscellaneous	.0280
Total variable cost	.1410

^aGasoline, oil and grease, and tire costs adjusted to represent 1969 conditions.

Source: John S. Hobson, "Optimum Number, Size, and Location of Egg Processing Plants in Indiana" (unpublished Master's thesis, Purdue University, 1968).

TABLE B-2.--Annual fixed costs for tractor and refrigerated trailer used in egg distribution.

Cost Item	Annual Cost
	(dollars)
Depreciation ^a	
Equipment	4,723
Building and tools (maintenance shop and office space)	300
Insurance ^b	1,100
Interest ^c	1,500
Federal highway-use tax ^d	200
License and miscellaneous tax	900
Management and office salaries ^e	1,155
Administrative costs	700
Total	10,578
Annual fixed cost per mile ^f	.1763 (60,000)

^aSee Table B-1 for method of depreciation.

^bInsurance cost inflated approximately 10.0 per cent over 1966 data.

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Cost Item	Variable Operating Cost per Mile
	(dollars)
Fuel, diesel ^a	.0500
Tires	.0180
Maintenance	
Grease, oil	.0082
Repairs	.0160
Labor ^b	.0110
Miscellaneous	.0106
Refrigeration ^c	.0167
Total variable cost	.1305

^aFuel, tires, grease and oil, repairs, refrigeration and miscellaneous costs were inflated by 6 per cent. The inflator was the Wholesale Price Index of Motor Vehicles and Equipment.

^bLabor cost was inflated by 18.75 per cent to account for the increase in hourly wage rate for total private production and nonsupervisory, nonagricultural workers between 1966 and July 1969.

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Interest ^c	1,500
Federal highway-use tax ^d	200
License and miscellaneous tax	900
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Administrative costs	700
Total	10,578
Annual fixed cost per mile ^f	.1763 (60,000)

^aSee Table B-1 for method of depreciation.

^bInsurance cost inflated approximately 10.0 per cent over 1966 data.

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Labor ^b	.0110
Miscellaneous	.0106
Refrigeration ^c	.0167
Total variable cost	.1305

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^bLabor cost was inflated by 18.75 per cent to account for the increase in hourly wage rate for total private production and nonsupervisory, nonagricultural workers between 1966 and July 1969.

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Body	5,050			
Total	9,250			1,576

^aChassis was assumed to have salvage value of 10 per cent of original cost and the body of a salvage value of 50 per cent at the end of four years.

^bTwenty-five per cent per year of new cost less salvage value.

Source: John S. Hobson, "Optimum Number, Size, and Location of Egg Processing Plants in Indiana" (unpublished Master's thesis, Purdue University, 1968).

TABLE B-5.--Annual fixed costs for 300-case straight truck, refrigerated.

Cost Item	Annual Cost
	(dollars)
Depreciation ^a	1,576
Interest ^b	488
License	350
Insurance	500
Management, office, and administrative costs ^c	1,050
Total	3,964
Annual fixed cost per mile ^d	.0660

^aSee Table B-4.

^bComputed at 8.0 per cent on midlife value of equipment.

^cBased on Costs of Operating Exempt For-Hire Motor Carriers of Agricultural Commodities, A Pilot Study in Delaware, Maryland and Virginia, ERS 109, ERS-USDA, 1960.

^dAssuming 60,000 miles per year.

Source: Data adopted from J. S. Hobson, "Optimum Number, Size, and Location of Egg Processing Plants in Indiana" (unpublished Master's thesis, Purdue University, 1968).

TABLE B-6.--Variable operating cost per mile for 300-case refrigerated truck.

Cost Item	Variable Operating Cost per Mile
	(dollars)
Gasoline ^a	.0520
Oil, grease	.0060
Tires	.0550
Miscellaneous	.0280
Total variable cost	.1410

^aGasoline, oil and grease, and tire costs adjusted to represent 1969 conditions.

Source: John S. Hobson, "Optimum Number, Size, and Location of Egg Processing Plants in Indiana" (unpublished Master's thesis, Purdue University, 1968).

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