COMPUTER APPLICATIONS IN LOGISTICS/DISTRIBUTION

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Discusses how the computer is and can be used to improve the management of logistics activities in the food industry

Before we begin a detailed discussion, let's make a few observations about the computer and its potential for use in the food industry.

Computer Usage

The computer entered the business world less than two decades ago. Since that time, it has proved to be a most effective force in increasing productivity of many firms. The food industry has been at the forefront in applying this technology to its logistics problems. To illustrate, Bud LaLonde recently concluded a survey of the NCPDM membership. The purpose was to determine the scope and nature of computer applications in the membership companies. The food industry was well represented in this survey with over 20% of the total responses. I want to restate a few selected statistics to show you where the computer is being applied, and where there is relatively little use (Table 1). Note that inventory control and order processing lead the list. This should not be surprising since the technology was developed early and computer application to these problems was often used as a sweetener to acquire a computer by the firm.

TABLE I

COMPUTER USE IN SELECTED DISTRIBUTION ACTIVITIES OF NCPDM MEMBERSHIP FIRMS

Activity	Presently Used	Development Stage	Planning Stage
Inventory Control	84.1%	3.7%	4.7%
Order Processing	79.4	6.5	6.5
Facilities Studies	45.8	8.4	8.4
Freight Rates	16.8	15.9	23.4
Vehicle Routing	11.2	4.7	15.0

Source: B. J. LaLonde and Karl Auker, "A Survey of Computer Applications and Practices in Transportation and Distribution", Proceedings of the National Council of Physical Distribution Management, 1972, pp. 227-46.

Only about one half of the facilities studied utilize the computer, probably because of the high initial investment required in both direct dollars and indirect costs of company personnel. There is not much use made of the computer for vehicle scheduling. The computer technology is available to deal with such problems and it will just be a matter of time until more use is made of it.

Computerizing freight rates is seeing a high level of development activity though the actual use of the computer remains relatively low. The problem does seem to be yielding as evidenced by the growing number of firms offering such services.

Traffic Management Magazine surveyed 500 shippers from Fortune's list of major corporations. Similar results were found.

Potential for Productivity Gains

The food industry represents especially fertile area for the application of computer methods. The industry unlike so many others is characterized by substantial product variety and high volume of throughput in the distribution system. This contributes to the food industry being ranked above all others in the cost of physical distribution as a percent of sales. Using a two-year average, physical distribution costs are 32 percent of sales (Table 2). With costs of this magnitude, even small pro ductivity gains can result in substantial cost improvement.

TABLE 2

Average Distribution Costs as a Percent of Sales in Selected Industries

Industry	Percent of Sales
Food & Food Products	32.0
Primary & Fabricated Metals	29.2
Chemicals, Petroleum & Rubber Products	23.8
Paper & Paper Products	18.1
Wood Products	16.0
Textiles	16.2
Transportation Equipment	10.2
Machinery (Elec. & Nonelec.)	10.0

Source: Richard E. Snyder, "Physical Distribution Costs: A Two-Year Analysis", Distribution Age, Vol. 62 (January, 1963), pp. 50-1.

Some Key Problems

Let's turn now to some key problems that are likely to concern you in the planning and operation of your business. We will consider the following major ones: (1) facility location, (2) inventory control, (3) vehicle routing, and (4) warehouse planning. This selective list does mean that we must leave for future discussion such interesting problems as rate retrieval, order entry system design, warehouse dock design, stock retrieval, and the like.

Facility Location

The competitive nature of the products in the food industry and the resulting need for high levels of customer service make the location of distribution centers a vital topic. Transportation costs, inventory costs, and order processing costs, that is the major logistics costs, are closely associated with the number, size, and location of the distribution centers in the logistics system.

The location problem breaks down into two parts. First is the overall problem solution. That is, we wish to answer a series of questions about the national distribution system.

- How many distribution centers should there be?

- Where should they be located?

- How should customers be assigned to these distribution centers?

- What size should the distribution centers be to handle the volume of throughput?

- How should the distribution centers be assigned to the supplying plants?

Second, within a designated region, the exact location of a distribution center must be determined. This problem deals with many more intangibles such as quality of transportation services available, zoning restrictions, and taxation laws.

The computer has been applied much more to the first problem. So this is the one we will consider.

Many facility location models have been developed beginning as early as 1957. These models have involved such familiar procedures as linear programming, computer simulation, and heuristic methods. Problem solutions in the Heinz Co., the Nestle Co., and Hunt-Wesson Foods, Inc. are just a few examples of successful applications of these methods.

Time limitations prevent a detailed discussion of many of these methods. However, I do want to mention a few to give you a flavor of what is available. The first is a computer simulation model that was developed at the request of the Heinz Company. In its original version, there is now an improved version, it replicated the distribution system with 4000 customers, 40 warehouses, and 15 factories. The model makes provision for a wide range of costs such as freight costs, local delivery costs, warehousing costs both investment and operating, handling costs, taxes, and more.

The classic models can be criticized because they did not take inventory control into account, did not handle the dynamic nature of the location problem, and generally required the use of outside consultants to service the model. Two recent model additions called DSS and LREPS are worthy of note.

The DSS (Distribution System Simulator) model is a recent product of IBM. The great appeal of this model is that it is "customerized". Through a series of about 400 questions a user completely specifies his distribution system as to inventory policies used, forecasting method, shipment policies, form of the output reports, etc. Through the processing of these questionnaire answer sheets, a model is pieced together that will reasonably replicate your distribution system.

The DSS package does not require programming experience of the user, though technical expertise is necessary to answer the questionnaire. To purchase the model would cost approximately $35,000.

The second model is called LREPS (Long Range Environmental Planning Simulator). This is a computer simulation model which was designed to replicate product flows in the national distribution system of a manufacturer of packaged goods. By manipulating this model, it is possible to evaluate various system design configurations. Because this particular model is quite robust, it is possible to determine good designs for distribution system elements and activities such as order processing, inventory policy, transportation service selection, and materials handling.

While a number of models have been developed over the past 10 years that can deal with most of these design issues, the LREPS model is unique in several respects. First, it is dynamic. This means that the model can be used to develop good system configurations when changes in demand and costs are anticipated over time. The model determines <u>when</u> the system configuration should be altered and to <u>what</u> the changes should be made.

Second, it includes inventory control policy with the problem of inventory location. <u>When</u> and in <u>what</u> quantities to replenish stocks in the system is interrelated with where the stocks are located. By playing off inventory policy with location, lower costs can be achieved than with more simply constructed models.

Inventory Policy

Let's turn now to inventory policy. We can easily observe that the computer has been more successfully applied to inventory control than any other problem area. This is not surprising when we recognize that inventory costs represent on the average 1/3 of the physical distribution dollar, roughly 25% of the average value of inventory annually, and are increasing as interest rates continue their upward trend.

What is the inventory problem? Recognize that inventories are not really necessary if our transportation and production system could respond instantly to changes in demand. To the extent that designing a distribution system with this instantaneous response is not practical, inventories are used as a buffer. The cost of carrying inventories is offset by the reduced transportation and production costs that can be achieved. This requires that we maintain adequate supplies throughout the distribution system to meet customer demand in between replenishment deliveries.

The problem then is one of keeping track of the current level of all product line items in all warehouses, forecasting the demand that will occur on these inventories, and deciding when to reorder. This is a repetitive task that the computer handles very well.

Development of or redesign of computerized inventory control procedures in your firm is likely to be handled in one of two ways. First, you may wish to have a customized model that fits your needs exactly. While this is costly, you can be assured that the input and the output format will fit your business. But perhaps more importantly, company personnel can be involved from the outset so that success of the project can be achieved clear through implementation.

Second, there is a wide variety of prepackaged programs available from computer companies that sell both hardware and software.

Computerized inventory control procedures must always be put into perspective with manual ones. Computerized procedures may be the best choice when (1) there is a reasonable amount of sales activity on each item, (2) the company can justify the initial capital and human resource investment that is required, (3) there are thousands of product items to be tracked, and (4) new products or product promotions do not represent a large proportion of the total activity in the system at any one time. Otherwise, the flexibility and low initial cost of the manual system may be more appealing.

Vehicle Routing

The problem of vehicle routing is a very obvious one in food distribution. With so many retail food operations being served from centralized storage points, deliveries must be frequent. This makes scheduling and routing of delivery trucks a vital problem to consider. Small inefficiencies on each route can quickly compound into large diseconomies.

With a fleet of trucks, a grocery company makes deliveries within 24 hours to any of the many retail stores upon receipt of an order. Because the order mix, order volume, and stores placing an order are changing on a daily basis, the best routing patterns depend on the truck capacity mix, driver time limitations, travel times between customers, and order composition. These routing patterns must constantly be recomputed. Thus, the computer is well suited to this problem.

A number of approaches have been developed to deal with such problems. However, one method stands above the rest in terms of its popularity and general availability. This is known as the Clarke and Wright vehicle scheduling method. It has proven to be effective and efficient. It is also available as an IBM software package. Several types of data inputs are needed. First, a description of the location and travel times between customers and/or the distribution center is needed.

Second, requests for delivery in terms of product volume and mix is obtained from customer orders. Third, limitations is the form of the number of vehicles and their capacities, and driver time restrictions are entered.

The problem described here is but one of many to which such a procedure could be applied. Additional examples are carrier routing in pick up and delivery service and defining and scheduling salesmen to sales territories and customers.

Warehouse Planning

In food distribution where logistics costs represent a high proportion of the sales dollar, it is necessary to look for cost economies everywhere through the logistics system, even inside the warehouse. One such problem area is the layout of the stock within the storage and order picking bays. The high throughput of food distribution warehouses means that materials handling costs are significant. Since stock layout directly effects these costs, layout becomes a significant planning problem.

The problem of stock layout can be described as follows. A typical product moves from receiving point to a semi-permanent storage area. From there, it is moved to the break bulk or order picking area, and then to the outbound docks. The question becomes, where should each product be placed so as to minimize the total materials handling costs? Since two products cannot occupy the same location, the problem is one of allocating the products throughout the warehouse.

Several computer based methods have been developed to deal with this problem. Two are of note. The first is a linear programming approach. Here the problem is formulated to fit a standard linear programming routine. Such routines are now universally available.

The second is a model known as CRAFT (Computerized Relative Allocation of Facilities Technique). This model, though originally designed to aid the layout of production facilities, is applicable to warehouse stock layout as well. The principle behind CRAFT, and a straight linear programming model as well, is that the model will interchange one product location for that of another. This process continues until no further cost improvements can be found.

Implementation

To keep the above discussion from being just conceptual, I want to say a word about putting these methods to use. Where these models can be obtained, how they can be implemented, and where you can get help with them are questions to which some answers will be suggested.

Obtaining the Models

A number of sources exist for obtaining these models. Chief among these are computer companies that offer software packages along with computer equipment and services, software companies specializing in providing computerized versions of the models, commercial consultants who specialize in handling distribution problems, and university professors who are concerned with the logistics area.

Perhaps of more concern than simply where to obtain the models is the issue of whether you should use an "off-the-shelf" model, use a customized version of it, or develop a custom designed model to fit your specific application. This is a philosophical issue and cannot be resolved with hard and fast rules. An "off-the-shelf" model is appealing because it is relatively inexpensive. But too often the design considerations are averaged across a wide variety of problem circumstances so that there may be some problems with matching the model to individual circumstances. Of course, the more custom the model becomes, generally the more expensive it is. For example, some custom facility planning models cost as much as $100,000 to develop. However, custom models have a higher potential for manager appeal since they are often more credible to him and his associates. The cost of custom models may more than be offset by the improved acceptance that it has over "off-the-shelf" models. Probably a good decision rule here is to tend toward "off-the-shelf" models if (1) your problem is fairly standard with that of many other companies, (2) the cost of acquiring the model is a concern, and (3) the presence of the model in the organization and its results are likely to be easily accepted by the personnel. Otherwise, a more customized model could be the better choice.

Concerns in Implementation

Once a model has been obtained, there are three major tasks that must be performed before the model can become an effective planning or operational tool. These are (1) data collection, (2) personnel coordination, and (3) pretesting the results.

Data collection. Collecting data for a model is often an expensive, unexciting, and necessary task. It can involve many hours of company personnel time that does not show up on the profit and loss statement as an assignable cost. Yet, the performance of any model cannot be better than its data inputs.

Data collection can be facilitated by developing a table that shows the specific data items to be collected, their dimensions, the probable source, date to be acquired, and who has the responsibility for collection. This table is the plan for data collection as well as a control device. It works well where a number of people in different functional areas of the firm must be involved in providing the data.

Personnel coordination. One of the real dangers in using these computer models is that they will not be accepted by the personnel of the firm. No model is likely to realize its full potential unless those that must deal with the model and its results accept what it can do. One of the best ways to gain this acceptance or understanding early of what the problems of implementation are likely to be is to set up a coordinating committee of all potentially affected people and involve them in the planning stages of the modeling effort. A good bit of the negative organizational energy can be vented and dealt with before it can undermine the project.

Pretesting the results. The final suggestion of pretesting the model results is one that is too often overlooked in the haste to put the model to work. Pilot testing the model in an actual but controlled situation can build often needed confidence in the model and provide a final opportunity to establish the credibility of the model before making major commitments based on the model results.

Getting Help

It has been assumed throughout this discussion that you are not particularly skilled in the finer points of mathematical analysis, but have an interest in utilizing the available models. It is very likely that you will need some help. Sources of such help are readily available. First, look to your own staff people. If you are associated with a large firm, it is likely that such help is available from analysts within the physical distribution function or at least from a centralized operations research group.

Second, an outside management consulting firm can be a source of help. A number of consulting groups now specialize in transportation and distribution problems. They may also be able to provide a consulting package of both model and expertise. Third, university professors can also be a source of information in this field.