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What Operations Research Means to the Accountant

Joe F. Moore

"Operations research" still has an esoteric and forbidding sound to many businessmen and their advisors. Yet it can be a significant aid—if supported by the right data. And this accountants can supply if they know the needs—

WHAT OPERATIONS RESEARCH MEANS TO THE ACCOUNTANT

by Joe F. Moore

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Intimidated by the mathematical symbolism and scientific jargon of operations research, many accountants have tended to view this relatively new field of management thought with hostility or indifference. Often they have either opposed it as a potential competitor in the supplying of information to management or ignored it as a fad that will go away.

Such reactions are shortsighted. The interplay between the operations researcher (or management scientist) and the accountant is already extensive, and it is growing. Accounting is both a supplier to and a customer of operations research; much of the management scientist's raw data must come from the accounting department, and many of his recommendations must be carried out through the accounting system. As the operations research approach begins to exert a strong influence on management thinking, it is becoming more and more important for the accountant to understand this new discipline and learn to work with its practitioners.

Definition

The term operations research can be defined on two levels: in terms of philosophy and in terms of technique. On the philosophical level, operations research may be defined as the application of scientific methods to problems that have traditionally been considered nonscientific. In terms of technique, operations research may be defined as a methodology that includes such techniques as mathematical simulation, statistics, optimization, and various methods of electronic computation.

Operations research can properly be called a scientific discipline. It was originally formalized during the years of World War II and began to find industrial appli-

cation a few years after the war.

As an approach to problem solving, operations research may be compared with the early work of John Galbreath and other pioneers in the field of industrial engineering. Galbreath's classic study of bricklaying is a good example of the application of scientific methods—in that case analyzing the various energy and motion requirements of mortaring bricks into place in a vertical wall.

The concept that many manual tasks could be studied, organized, and made more efficient through observation and calculation was revolutionary at the beginning of the Twentieth Century. Today, this concept is commonplace, and virtually all industrial companies have industrial engineering departments. Operations research is closely related to this discipline, and, indeed, many universities place their operations research curricula in schools of industrial engineering.

However, the subjects for operations research study differ from the various production operations that are subject to study by the conventional industrial engineering techniques. Operations research study in industry concerns activities at the management level in a corporation. Usually, the problem involves situations that cannot be counted or measured by weight, color, or dimension. Typically, the operations research study deals with the interactions among management decisions, production efficiency, product demand, manufacturing costs, and product price. Therefore, an operations research study is primarily based on economic measurements. Ordinarily, the principal objective of an operations research study is the reduction of all measurements of efficiency and performance to common economic units.

Although application of operations research techniques began before the advent of the electronic computer, the practice of operations research today is almost completely dependent on these machines. Since operations research frequently involves systems that cannot be reproduced in a laboratory or on a microscopic scale, the techniques of mathematical simulation become important. The simulation of an economic system having any degree of complexity is impossible without the modern electronic computer. Statistical analysis of large quantities of data, such as marketing, manufacturing, and price data, is also impractical without a computer.

Objectives

There is no such thing as an "average" operations research study, but all projects have certain things in common, including organization of the work effort. Any operations research study must begin with a definition of the problem. This initial step is more important in operations research work than in any other field of scientific study because the problems to be solved are generally broad in scope with many facets.

The original problem statement may simply consist of describing two or three symptoms of trouble and stating that the purpose of the study is to find the cause or causes. Occasionally the problem can be stated more succinctly, e.g., to define an optimum strategy for scheduling production and controlling inventory to supply a specific market.

During the problem definition phase a good operations research team determines the potential profit that may be realized as a result of the study. Information must be available to calculate the economic effects of various actions if the researcher is to predict what profit improvements might be possible through some increase in efficiency, either in decision making or in the operation of a plant or organization.

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Information gathering

When the objectives of the study have been clearly defined, the next step is to survey the information available. This information can be of two types. The first type, data that objectively measure events, includes such traditional data as manufacturing costs, production rates, sales prices, and transportation costs. The second type of information includes management experience developed through years of decision making that can provide insight into cause and effect relationships.

One specific technique of operations research, industrial dynamics, uses only data that reflect cause and effect relationships and ignores the traditional types of data used to measure performance. If all cause and effect relationships can be properly understood and correctly related to each other, then the dynamic operation of a business or physical system can be simulated and controlled to improve performance.

Model building

The next step in an operations research study is usually the construction of mathematical models, which serve the same purpose as laboratory equipment. These models permit experimentation with the system to study present performance and to develop new methods of improving performance. Many specific techniques have been developed for solving specific classes of mathematical models. Some common ones include linear programing models and transportation or distribution models. Experi-

mentation with these models and the use of optimizing techniques to determine how a system operates best under a specific set of circumstances provide data that the operations research analyst uses to develop his broad conclusions.

Recommendations

The conclusions and recommendations for actions resulting from an operations research study can take several general forms.

First, a specific recommendation might be made to modify some operating practice or to pursue some specifically different sales strategy. In the same manner, a recommendation might describe a new raw material purchasing policy or new manufacturing procedures to reduce operating costs.

A second type of recommendation might list several alternative actions for management decision. These recommendations could include capital investment programs, new product introductions, or the elimination of certain unprofitable operations.

Both of these first two types of recommendations provide specific objective answers that could be implemented to obtain the desired results. It is possible, however, to reach a totally different kind of recommendation or conclusion, which reviews the decision processes and attempts to define better decision structures or procedures for performance of day-to-day corporate business. For example, the operations research study might recommend a new information or reporting system to inform specific managers of facts needed to make routine decisions. This sort of conclusion would be appropriate if the operations research analyst simulated the cause and effect relationships among events and decisions and discovered that decisions were not being made in accordance with the profit objectives of the corporation. This inconsistency could arise because events were being measured inadequately, because the measurements of events were being reported to the incorrect corporate officer, because decisions were being made at the wrong level of management, or because measurements were being made and reported in terms that were not compatible with the experience and judgment of the man making the decisions. The implementation of study recommendations in each of these cases would involve the development of a new management information system or modification of an existing system.

Another kind of conclusion that might result from an operations research study is a recommendation that some particular mathematical model or simulation be used to evaluate certain operating decisions. In this case the operations research study would create a tool that would be added to others that executives use in making their decisions. The management information system could be considered to include mathematical models and simulations that reflect the effects of certain decisions on operations and on corporate profitability.

Operations research study can result in a number of conclusions. Some are: A recommendation might be made to modify some operating practice or pursue some specifically different sales strategy. Another might list several alternative actions for management decision. These recommendations could include capital investment programs, new product introductions, or the elimination of certain unprofitable investments.

Relation to accounting

An operations research study and a company's accounting system are closely related in several ways. The accounting system is the primary source of much of the data used in the preparation of mathematical models or in statistical studies. The accounting system provides a type of information useful in defining cause and effect relationships in the decision making process since most data for decisions must evolve from the accounting system. And the accounting system may be used as a vehicle for implementing the recommendations and conclusions of the study.

Data availability

The use of accounting data in operations research work can be discussed from two standpoints: (1) how these data are developed and recorded, and (2) the ease

with which various types of data can be retrieved.

The most important data that an accounting system must provide for management decision are those that provide a basis for estimating the effect on profitability of some particular projected action. If the cost of an operation is particularly low, a manager may decide to increase the extent of this operation. If the cost appears to be unduly high, the manager may decide to reduce or eliminate the operation. Since operations research personnel are interested in devising methods for improving decision making, the operations research analyst needs the same data that the manager would use.

The proper aggregation and accumulation of costs will vary according to the type of decision involved. For example, a decision to eliminate—or expand—a marketing area must take into account the total cost of the marketing effort. Since the decision affects a major segment of the marketing function, the total costs must be all-inclusive, from the salesman to headquarters administrative overhead. Conversely, a decision to reallocate customers to warehouses or distribution points requires a different accumulation of costs. In this case, many costs are fixed with respect to these choices and are not involved in evaluating the alternatives.

Before making a decision to build a new process plant, the executive must consider different cost factors from those involved in a decision to expand an existing plant. To build a new plant, more land must be provided, new equipment must be stocked for maintenance and repairs, and new operating personnel must be hired. Expansion of an existing facility might not require hiring more operating personnel, and additional labor costs would be negligible. Addition of a similar process in an existing plant would probably not require maintaining stocks of new equipment, and the administrative burden for an expanded plant would be different from that for a new manufacturing facility.

Analysis of these problems depends heavily on the separation of fixed, semi-fixed, and variable costs. An operations research specialist recognizes that different questions must be answered with different classes of cost data.

Data deficiencies

It is certainly not reasonable to assume that all accounting systems will be readily able to provide cost breakdowns tailored to every individual's specific need. However, an accounting system that recognizes the difference between fixed and variable costs is more useful for analysis and decision making than one that treats all costs equally. In our operations research work we have been able to make ready use of existing accounting data where costs have been individually categorized in detailed reports before their accumulation for overall profit and loss calculations. When costs are accumulated methodically into categories that have a reasonable relation to the physical events that incur those costs, the accounting system can be directly useful to the manager and the operations research analyst.

Conversely, an accounting system that does not develop individual cost breakdowns related to physical events but produces only accumulated and allocated cost reports is not useful for operations research analysis. In addition, such a system is dangerous for a manager to use if he is not completely cognizant of how all the cost data are developed. In one recent case it was necessary for the operations research analysts to develop a complete data processing retrieval system, starting with magnetic tape reels containing source transaction files. The company accounting system, through meaningless descriptions of cost categories and arbitrary allocations, made it difficult to determine the relation of costs to physical events.

An example of cost allocations

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that obscure the relationships the operations research analyst is trying to develop can be cited from a recent study. The client had an oil terminal located near a state line; different tax structures existed for the two states. A pipeline to a truck-loading rack was constructed across the state line. The truck-loading rack was assigned a separate location code from the pipeline and expenses were allocated to the two location codes by the terminal accounting clerks. The costs of the combined operation of loading rack and terminal were allocated on a capital investment basis. There was no way to determine from the cost accounting system the effect of increasing or decreasing the rate of loading at the truck-loading rack.

Another example is a situation in which a warehouse distributes products to dealers and also serves as a retail outlet operating through a single office. If different location codes are established for these two operations and the cost allocated on some basis, cost records will not show whether or not the retail operation is actually showing a profit or what are true costs of warehouse distribution.

These problems pose particular difficulties in operations research studies because the studies are usually not limited to a single terminal or single warehouse but include all the terminals and warehouses of a given company. Frequently, a laborious search through each cost center structure is necessary to determine cost allocation methods and to ensure that all costs are included and that costs relevant to the operations research study are available.

It is usually assumed that an accounting system must be designed to fulfill certain specific requirements. A management information system, however, must be designed to fulfill a myriad of information requirements, many of which cannot be foreseen or predicted at the time the system is developed.

Data retrieval

Personnel performing an operations research study also encounter the problem of retrieving data from an accounting system. There is no single method that can conveniently provide retrieval for all varieties of cost accounting data. However, it is common in operations research studies to require retrieval of data that are closer to the source transactions than the finished accounting reports. This may necessitate development of an accounting system designed to permit starting with source transaction files, which would be saved, and to provide facilities for intermediate processing and aggregation without having to complete the prescribed fiscal accounting procedures.

The modern concept of a computer-based management information system implies flexible data retrieval capabilities and modularity in the structure of data processing programs. It is usually assumed that an accounting system must fulfill certain specific requirements. A management information system, however, must be designed to fulfill a myriad of information requirements, many of which cannot be foreseen or predicted at the time the system is developed. Therefore, retrieval ability and modularity of processing become primary design criteria. When these design criteria are satisfied, corporate operating data may be used by various people for a variety of purposes. The operations research analyst becomes one of a large group of people who utilize the corporate information system.

Cost center application

As was previously discussed, the allocation of costs is a major problem in determining the relation of accounting data to particular physical events. This same problem of cost allocation appears in another form: the definition of cost center and profit center. Giving a manager profit responsibility and some incentive to improve performance seems like a good practice. However, there are so many pitfalls in such an arrangement that it would not surprise me if more of these systems were detracting from corporate profits than contributing to them. A direct consequence of this management practice is that cost and profit center definitions be-

come imbedded in the accounting system.

Misapplication

An example of cost center accounting misapplication that resulted in financial loss may be cited from our experience. A company set up all of its plants as profit centers and accumulated all fixed and controllable operating costs at the plant level. Sales and administrative costs were allocated on a relatively fixed formula. The sales outlets were also placed on a profit center basis and given the opportunity of buying products from that plant which would supply them at the lowest cost. Freight was equalized on all shipments.

As a result, if one plant begins losing volume, its unit cost rises because of the fixed cost allocations not under control of the plant manager. When the plant's costs rise, then it cannot compete with other company plants in supplying products to sales outlets. The plant's volume becomes distributed over all other plants, lowering their apparent costs and raising its apparent costs still further. This process continues until the corporate management decides that the plant is unprofitable and must be closed. This decision is then followed by a decision to build a new plant. In this particular case, new plant designs have not achieved any operating economies over plants of much earlier vintage. Therefore, when new plants are constructed, they have controllable operating costs virtually identical to those of the plant that was closed. All overhead costs are then reallocated to the new plant, and the cycle begins all over again.

Not only are these events resulting in the expenditure of substantial capital funds with questionable justification, but transportation costs paid to move products from plant to distribution point are disguised through the practice of equalizing freight rates. The company in question is slowly approaching a financial crisis because of this situation. However, results of the operations research study have demonstrated to company management that the accounting system is not providing appropriate information to the managers and that the existing concept of allocating and treating costs is destructive to rational decision making.

Conclusion

Operations research is profoundly affecting the thinking and actions of modern managers. Therefore, the needs of the operations research analyst are rapidly becoming the needs of the scientific and analytical manager.

It becomes necessary for people designing accounting systems to attain an understanding of the decision processes that are inherent in their particular company or industry. This knowledge is not limited to understanding the physical operations of a particular plant or its methods of transacting business. It requires an understanding of the decision processes involved in conducting the corporation's business on a short- and long-range basis.

The information requirements for these decision processes must be delineated. The resulting accounting system must fulfill the fiscal and auditing requirements of the corporation. It must also provide a flexible capability for retrieving and analyzing corporate statistics of all kinds by methods not necessarily foreseen at the time the total system is designed and initiated.

Finally, the modern accounting system must reflect the constant change that occurs in the structure of modern corporations. Modern management control requires that information systems expand and keep pace with the rapid changes in products and organization that are dictated by our economy. This requirement presents a challenge that can be met by effective use of modern operations research techniques.

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