Operations Research And Operations Management: From Selective Optimization To System Optimization

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ABSTRACT

The focus of this research paper is to discuss the development of Operations Management (OM) and Operations Research (OR) with respect to their use within the organization's decision-making structure. In addition, the difference in the tools and techniques of the two fields is addressed. The question is raised as to how distinct the two academic fields have become in light of the application of their models to the service industry. Suggestions are made regarding the possibility of incorporating OM/OR models and their output into the decision making structure of the organization towards the goal of "system optimization".

ORIGINS OF OPERATIONS MANAGEMENT AND OPERATIONS RESEARCH

A comparison of the origins of operations management and operations research reveals that both are an innovation of the 20th century. The origin of operations research was in England, circa 1937, and has its roots in scientific management, with its first significant applications to military operations in both World War I and World War II. Operations management had its origins in the early factory system, and was more associated with physical production in a factory environment and it too was strongly influenced by the scientific method. (Chase, Aquilano and Jacobs, 2001). Operations management however, by way of distinction, is more commonly applied to the management of organizational resources in terms of both effectiveness and efficiency and has equal application in the service sector as well as the manufacturing sector. Both OR and OM are mathematically oriented, utilize the scientific method, and produce information output for managerial decision making.

CONCEPTUAL/PHILOSOPHICAL BRIEF DISCUSSION

At the conceptual or philosophical level, OM and OR differ substantially. OM is mainly concerned with the managing of production resources critical to strategic growth and competitiveness of a company or organization. It entails the design, operation, control, and updating of systems responsible for the productive use of human resources, equipment, and facilities in the development of a product or a service (Chase, Aquilano, Jacobs, 2001). Philosophically, therefore, OM is managerially and activity oriented while OR is mainly technique and mathematically oriented involving modeling a situation or a problem and finding an optimal solution for it (Anderson, Sweeney, Williams, 2002).

Decision support models of OR and OM are frequently utilized on an ad hoc basis. This may be true more so for OR than OM models, since OM models tend to be integrated into functional areas of the organization such as in statistical process control in production, EOQ models in inventory management, and forecasting models in new-product development systems. Many of the models from both OR and OM tend not to be vertically and/or horizontally integrated into a total organizational system, except where standard operating procedures incorporate these models and their output. Vertical integration is frequently lacking in the sense that the management science models are not optimized to satisfy the needs of upper, middle, and lower management simultaneously. Horizontal integration is often lacking due to the absence of connecting mechanisms among the functional subsystems of the organizational information system. It is recognized that this may be viewed as a deficiency of operations research, operations management, or the organizational information system, depending upon one's frame of reference. The point of emphasis, however, should relate to a constructive approach toward a conceptual methodology for resolving this issue, not in determining where the deficiency rests or why it exists. In other words, the thrust should be aimed at describing possible connecting links between the fields, which will then permit horizontally and vertically integrated decision support models. From this perspective, it appears that OM models may be more functionally integrated into an organization than OR models. A brief review of the quantitative models from operations research, and both quantitative and qualitative models from operations management, illuminate the differences between the two fields and the extent to which their models are incorporated into organizational decision-making.

THE MODELS

At the conceptual level, operations management and operations research display a marked degree of similarity among their quantitative techniques. Included in the quantitative models of operations research are:

1. Decision analysis models employ states of nature and associated probabilities, outcomes, and alternatives for the purpose of selecting the best alternative.
2. Linear programming models optimize "objective functions" through a set of linear equations designed to allocate limited resources among competing demands. Included in these models are transportation models which try to minimize the cost of shipments between designated sources and destinations and assignment models which assign specific "jobs" to specific "candidates", such as jobs to machines, in an optimal way.
3. Integer programming models where some or all of the decision recommendations can be integer values.
4. Nonlinear programming models allow the functions making up the problem to be nonlinear, i.e., quadratic, cubic, or even a higher exponential for the decision variables involved (Chase, Aquilano, and Jacobs, 2001).
5. Game theory models imbed players in a simulated business environment where decisions at one time (quarter) affect the conditions under which the subsequent decisions are made (Watson, 1981).
6. Network optimization models employ graphical descriptions of problems employing specialized solution procedures which optimize interrelated activities and their completion or flow from start to finish. Applications include areas such as transportation system design, information system design, and project scheduling (Anderson, Sweeney and Williams, 2002). Project management models monitor the execution of projects in terms of time, effort and cost. PERT/CPM (Program Evaluation and Review Technique/Critical Path Method) are the two techniques typically employed for this class of models (Chase, Aquilano, and Jacobs, 2001).
7. Inventory models monitor the cost of carrying, ordering, and purchasing inventory (Chase, Aquilano, and Jacobs, 2001).
8. Queuing models represent waiting lines in order to improve or speed up the service and to increase the efficiency of service centers (Watson, 1981).
9. Simulation techniques simulate a system under different "scenarios" and answer "what if" questions using a series of statistical results (Watson, 1981)
10. Dynamic programming models allow one to break up a large problem in such a fashion that once all the smaller problems have been solved, one is left with an optimal solution to the large problem (Anderson, Sweeney, and Williams, 2002).
11. Forecasting models are used to predict future aspects of business operation (Anderson, Sweeney, and Williams, 2002). They include averages, moving averages, weighted moving averages, exponential smoothing (EXPOSM), linear trend models, and simple and multiple regression models.
12. Markov decision models are typically used for the study of the evolution of certain systems over repeated trials (Anderson, Sweeney, and Williams, 2002).

The techniques of operations management are a combination of quantitative and qualitative. The following list includes most of the major models in this category:

1. Financial analysis including breakeven analysis, cash flow, net present value, and cost-effectiveness/cost-benefit analysis for selecting the best alternative.
2. Quality control systems which monitor the process and ascertain whether it is in control or not. Included in this model are sampling design and inspection used to minimize the number of defects produced (statistical process control) and acceptance sampling which determines the acceptance or rejection of products or services based on specifications and tolerances.
3. Forecasting techniques (defined earlier).
4. Production planning and control, including material requirements planning which determine and monitor the transformation of inputs into outputs. (Moore and Jablonski, 1969)
5. Linear programming (defined earlier).
6. Scheduling systems are logical procedures managers employ to promote efficient and orderly scheduling of resources.
7. Waiting line or queuing theory (defined earlier).
8. Inventory systems (defined earlier).
9. Simulation techniques (defined earlier).
10. Work measurement techniques designed to measure the time required to complete a specific amount of work under certain conditions to promote efficiency and effectiveness.
11. Learning curve technology displays the relationship between (decreases in) unit production time and the cumulative number of units produced. It has wide applications in the business world.
12. The experience curve which differs from the learning curve in that it applies to the relationship between all costs (selling, producing, engineering and financing) and accumulated experience. (Hamermesh, 1986)
13. Project management and critical path scheduling as a specific application of network theory.
14. Safety management or occupational safety and health management consists of the enforcement, monitoring, and application of safety legislation throughout the organization. (Goetsch, 2000)
15. Ergonomics/human factors engineering which includes techniques which incorporate the consideration of human use when designing work, equipment, facilities, environments, etc. (McCormick, 1976)
16. Industrial psychology which includes the methods and procedures that increase the understanding of the nature of work performance and satisfaction, the factors which influence them, and the maximization of the outcome of work. (Korman, 1971)
17. Location and capacity planning forecasting techniques used by managers to plan future capacity to meet market demand and to procure the needed inputs to produce this demand at optimum costs.
18. Productivity measurement and improvement: single, multi, and total productivity are measured to compare the company's performance with other competitors or to monitor the company's performance over time to see whether it is performing efficiently and effectively.

The tools and techniques listed in the area of operations research do not directly mesh with the functional structuring of management problems. However, operations management techniques appear to be more functionally oriented. Neither operations research nor operations management techniques are designed to replace managerial decision-making. The application of the techniques and concepts in both areas are designed to be used as a "decision support system", and in the case of operations management, are sometimes an integral part of the organizations' strategy (i.e., forecasting new product sales potential). In addition, the application of these models is not limited to technical decisions at the operational level within the management hierarchy. As previously stated, there are direct implications for the use of these models in the long-term planning of the organization (strategic level) for many firms. One element that may impact the “integration” of these techniques into the strategic level of the firm is the trade-off between achieving short/long-term goals. Frequently, there is pressure on operations management to produce annual profit regardless of the long-term “strategic” implications (Banks & Wheelwright, 1979). It has also been noted that “too many modeling attempts have either assumed a simplistic attitude about the planning process or have not acknowledged the nature of the planning process at all” (Lorange & Rockart, 1977). As a result, unrealistic, oversimplified, and/or under-perceived constraints lead to poor modeling.

Although the listings of techniques related to operations research and operations management indicate some overlapping of these two fields, the fields themselves are not indistinguishable from each other. It is the integration of these models into standard operating procedures and specifications defined by different functional areas of the firm that lend themselves for use and interpretation in direct application to decision making. The possibility of integrating these models into the organization's decision-making process implies that the output from the related algorithms can be (and are in many cases) incorporated into daily decision- making as well as an integral part of strategic objective evaluation. Perhaps computer-based, integrated management information systems should be the integrative vehicle between operations research technology and operations management techniques.

OM AND OR TEXTBOOK CONTENT

Several techniques are covered in both OM and OR textbooks. However, this is not to say that there is so much overlap as to make the two fields indistinguishable from each other. Many of the tools of the two fields are similar. However, OR tends to be strictly quantitative in character whereas OM exhibits psychosocial and socio-technical topics as well.

While these lists serve the necessary function of presenting the tools and techniques aspects of the fields, the listing related to OM has the appearance of being more functionally oriented than the OR listing. It is important to note that managers tend to avoid thinking in terms of abstract theoretical classifications and do not normally categorize their problem areas in these terms, since functional departmentation is still the most common type of organizational structure (Carlisle, 1973). As a consequence, the functional breakout is frequently more familiar to the manager and problem resolution may draw upon any number of the quantitative models listed above. Additionally, large-scale endeavors are often functionally oriented.

OM frequently stresses the psychosocial and socio-technical aspects of job design, work methods, work measurement, and wage payment. The tools and techniques of OM are applicable to a broad spectrum of management problems in both the horizontal and vertical organizational planes. Unfortunately the textbooks in Operations Management do not reflect the psychosocial and socio-technical aspects of the field. This is evidenced by the observation that, to our knowledge, only one book in OM today even mentions Safety Management, let alone contains a chapter on this critically important topic. In addition, the interaction of man with machine or ergonomics / human factors engineering is missing as well. Some of the blame for the lack of a clear distinction between these two fields lies may lie with textbook authors. Perhaps they need more association with managers who are working out in the field to see how many of them can do their job in the absence of OSHA training and compliance or how many are dealing with employees with low back pain and/or carpel tunnel syndrome.

USE OF OR AND OM TOOLS AND TECHNIQUES FOR SYSTEM OPTIMIZATION

Although many of the tools of these two fields are similar, operations research tends to be strictly quantitative in character whereas operations management exhibits psychosocial and socio-technical considerations. By means of an interactive integrated database, common data elements, work package identification, and module-to-module communication, the tools and techniques of operations management and operations research would seem to mesh and become interwoven computer-based functional applications. The use of these tools then changes the emphasis from structural to functional, from the use of individual tools and techniques to the use of combinations, and from selective optimization to system optimization. Next-generation software might include artificial intelligence to interpret quantitative results under different states of nature. An example of this would be sensitivity analysis that is automatically adjusted for exponential smoothing models in forecasting based on input that is updated daily/weekly/monthly directly from the management information system based on changes in trend (beta), random fluctuation levels (alpha), and seasonality (gamma). Another example is for the identification of incapable processes/equipment/employee/services from the generation of capability indices that are calculated based on the *process* mean of an operation/service versus the *specification* mean.

CONCLUSIONS

Both operations management and operations research, but especially operations management, give evidence of moving in the direction of placing greater emphasis on the "management" aspects of problems and a de-emphasis of the "techniques" aspects. If as suggested in this paper the fields of operations research and operations management are distinct in philosophy, if not totally separate in your tools and techniques, the question is how to integrate these fields into an organization's structure. It is proposed that the integrating ingredient could be an integrated information system/decision support system for the organization. In addition, through the identification of appropriate techniques from both fields, the organization's strategy and the attainment of strategic objectives could be supported or rejected based on the output of fully integrated OR/OM models.

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