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Economics of operations management: A research perspective

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Abstract

In response to intense competition from overseas in the last two decades, U.S. companies have instituted a variety of management practices in their quest to improve their competitiveness. Among the many practices that have been adopted by a large number of firms are just-in-time, total quality management, worker empowerment, and design for manufacturability. However, there has been little systematic analysis of the organizational factors that drive the adoption of these practices as well as their successful implementation. This paper posits that the theories and methods from economics can provide a useful aid in such an analysis. Using the basic tenets of economics, a structural framework is proposed to highlight critical issues in operations management that deserve attention. Examples from industry are used to illustrate how the framework may provide answers to questions that have received little attention in the research literature.

1. Introduction

In the 1970s and 1980s, many manufacturing organizations in the U.S. found themselves facing intense pressure from overseas competitors who could supply products of equal or higher quality at a lower cost. As a result, many new manufacturing and management practices have been implemented by these U.S. manufacturing organizations in their quest for major improvements in productivity and quality. Experimentation with new practices to manage operations is evident also in service organizations as they seek to increase their customer orientation. The proliferation of a wide range of new practices presents a new challenge for research in operations management (OM). Historically, the focus of OM research has been developing rich, normative models of manufacturing or service activities and employing these models to prescribe improved methods and algorithms to solve specified problems. However, we have very little systematic evidence about what characterizes the organizations that adopt particular types of operations management practices and what characterizes the conditions under which particular practices are more effective. There is also a need for theories to explain and predict the adoption of different OM practices and the success of these practices.

The objective of this paper is to argue that the theories and methods from the field of economics can provide a useful aid in answering the above questions. It should be made clear, however, that economics is not the only field that can provide us with theories and methods to analyze these issues. Indeed, it is important that as research in OM evolves, we also seek insights from other disciplines such as psychology, sociology and organizational behavior which can be used synergistically with economic

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analysis. Our focus here is on the potential contributions from using the tools and methods of economics. In contrast, Fine (1992) discusses economic issues in the specific context of technology evaluation. Using the basic tenets of economics, we propose here a structural framework that highlights some broad critical issues in operations management that deserve attention. We caution the reader that this paper is not an attempt at an exhaustive classification of research questions that can be addressed in the context of our framework. It is also not a tutorial on economic tools and their application to research on operations management issues. Rather, using examples from industry, we identify a variety of issues that are important to OM practice and can be addressed within an economic framework.

Many of the new OM practices have sought to direct the attention of the organization to adding greater value from the perspective of the customer. Value is sought to be added through these practices by reducing costs, improving quality, reducing lead times and increasing flexibility to react quickly to changing customer needs. These practices include just-in-time production, total quality management, worker empowerment and design for manufacturability.

Before we can be prescriptive about what organizations should adopt which practices, we need to have a clear understanding of why firms adopt these practices and whether these practices create the value that they are expected to create. For this purpose, we need theories to rigorously conceptualize these issues and predict practical outcomes, as well as empirical analyses that test these conceptualizations.

A lot has been written in the popular business press about the changes taking place in the operations management practices of U.S. organizations. Many of these books and articles contend that the adoption of such practices enable a firm to obtain a competitive advantage or that they enable them to offset the advantage enjoyed by a competitor. Competitive pressure is believed to be a key factor driving the implementation of new practices. However, much of the extant literature has viewed operations management problems from the perspective of a single firm optimizing under uncertainty; implicitly, all industry-level interactions are treated as those with passive competitors and subsumed within a variable modeling uncertainty. It is essential, therefore, that in understanding the pattern of choices of different practices by different firms in different industries, we explicitly employ models of firms in competition with each other and evaluate how competitive interactions influence a firm's optimal decisions.

Several models of competition exist in the economics literature that can be leveraged to address these important problems in operations management. These economic models range from that of a competitive equilibrium in an economy with a large number of firms and costless transmission of information (Arrow and Hahn, 1970; Debreu, 1959) to that of a competitive equilibrium in an oligopoly with a small number of firms with significant market power (Nash, 1950; Harsanyi, 1967). And, of course, these classical models have been extended to address a richer array of economic concerns (see (Tirole, 1988; Fudenberg and Tirole, 1991) for a review). The challenge before researchers in operations management is to further enrich the structure of these models to focus not only on cost, but also on quality, flexibility and lead time that are of concern from an operations perspective. Furthermore, such a development of a theoretical framework to analyze OM problems requires that we view these issues from the perspective of customers who demand the various attributes in a product or service in addition to the perspective of the producers who supply it as is commonly done in most extant OM analysis. This is essential to evaluate the full competitive ramifications of operations strategy decisions.

A second distinctive aspect emphasized by the new manufacturing practices such as total quality management, just-in-time production, and worker empowerment is the need for coordination between different individuals that comprise an organization. There is increasing recognition of the fact that the environments in which operational activities are performed are characterized by uncertainty and the potential exists to improve performance by learning about the environment to help resolve some of the existing uncertainty. Efforts to facilitate coordination and learning are confounded by the fact that the information available to different individuals in different parts of an organization can vary, and further, the objectives and incentives for each individual may

also differ from those of other stakeholders in the organization. As a result, implementation of any operations strategy requires a careful consideration of the information available and incentives provided to different individuals comprising the organization. Thus, the simultaneous consideration of the problems of several decision makers can considerably complicate the analysis of most common operations management problems ranging from new product development to production planning and control decisions.

Many economic models analyze the interplay between information, incentives and decision-making. These range from the early work on team behavior (Marschak and Radner, 1972) to more recent agency theory (Jensen and Meckling, 1976). While some of the assumptions of these models may not be appropriate in the OM context, the analytical methods of these models can be deployed to construct and analyze new models to represent OM problems. Such new models will also, in turn, serve to advance the field of economics (see, for example, (Milgrom and Roberts, 1990)).

So far, we have only discussed theoretical models that have the potential to be relevant to OM problems. However, empirical analysis is equally important as we seek to develop a better understanding of the choice and efficacy of OM practices, before we prescribe what practices organizations should adopt (Swamidass, 1991). Careful and systematic empirical documentation of adoption and implementation of OM practices, as well as their effects on key performance dimensions, is important because it provides the basis for developing theoretical models to explain the documented phenomena. Even after we have a base of alternative theories, and predictions that derive from them, empirical research is necessary to test these predictions. To the extent the empirical evidence contradicts the theoretical predictions, new challenges are presented for analytical research to augment or modify existing theoretical models or develop alternative models based on different assumptions. We believe that a coherent stream of research can develop in this manner from an economic (or psychological or sociological) theory basis to complement the extant algorithmic research-based operations research models.

Much of the empirical research will need to draw on actual operating data collected from the field. Thus, empirical researchers in OM will need to recognize explicitly that the data they use may result from some deliberate choices by managers and workers at their research site(s). In addition, unlike laboratory experiments, observed data are often influenced by several factors not central to the theory being tested, and therefore we need to control for such factors. Furthermore, researchers using panels of data over several periods of time and/or across several plants or organizations and simultaneously considering multiple dimensions of performance that influence each other need to recognize the possibility of simultaneity and serial and contemporaneous correlations in constructing their estimation models. As a result, econometric methods developed to test economic models using field data are likely to be particularly useful to empirical researchers in OM. Economic theories can also inform and advance empirical analyses in OM. For example, theories relating to production functions can be used to formalize the notions of best practices and benchmarking in world class manufacturing and the notions of technical efficiency can be used to formalize the notions of continuous improvement in operations (Cooper et al., 1995). In addition, econometric methods of frontier estimation such as data envelopment analysis (DEA) (Charnes et al., 1981; Banker, 1993) can be used to empirically identify best operations practices (Sinha, 1995).

The plan for the rest of this paper is as follows. In the next section, we consider the two aspects of decisions we have discussed in this section in greater detail. Section 3 then describes a classification of OM decision areas and we proceed to consider each of these decision areas in greater detail. For each decision area, we describe research issues that are amenable to theories and methods in economics and are motivated by anecdotal industry evidence and by our classification of different decision perspectives. Finally, Section 4 concludes the paper.

2. Classification of decision perspectives

In the previous section, we argued that there are two distinctive aspects to any analysis of new OM practices: (i) an *external perspective*, that explicitly considers the nature of competition in analyzing the

adoption of these practices; and (ii) an *internal perspective*, that focuses on the issues of coordination and motivation of employees within the organization. In this section, we further elaborate on these two perspectives.

2.1. External perspective

When considering the nature of competition and how it drives different OM practices, we can divide the issues to be considered into two broad categories: (i) the impact of industry structure on how these practices are adopted; and (ii) the scope of competitive advantage provided by such practices. We proceed to discuss each of these categories in greater detail.

2.1.1. Impact of industry structure

The main question of interest here is how the industry structure impacts different operations management decisions. Broadly speaking, we are concerned with how basic industry characteristics affect the adoption and successful implementation of the new OM practices. Some of the industry characteristics of interest include the number of competitors and their relative sizes, the degree of differentiation in the products of rival firms, the industry growth rate and the pace of technological change in the industry. Porter (1979) identifies five key competitive forces: rivalry among competing sellers, firms in other industries offering substitute products, potential new entrants, suppliers of key inputs and buyers.

As we discussed in the Introduction, the adoption of many of the innovative practices in OM in the U.S. has been attributed to competitive pressures, especially from overseas. In the mid-sixties, only 7% of the U.S. economy was exposed to international competition; by the 1980s, this figure exceeded 70% (Gwynne, 1992). Thus, while it is true that such competitive pressures have increased significantly over the last decade, it is less clear that the best strategy for a firm faced with intense competitive pressures is to "follow the leader". For example, while just-in-time practices have been viewed as a critical element of success for Japanese firms, Inman and Mehra (1990) found that many small firms simply cannot afford to convert to these practices, given the high costs of training, preventative maintenance and other activities required to implement them.

2.1.2. Scope of competitive advantage

The primary question of interest here is to what extent do different OM decisions provide a competitive advantage to a firm. This competitive advantage may manifest itself as a price advantage or an advantage along some other dimension of value to the customer such as delivery time, flexibility to changing customer needs or product quality. Also at issue here is whether the advantage is sustainable: Do any of these new management practices provide a competitive advantage that is sustainable over time, and if so, in what way? Or, do these practices result in quick adoption by all firms in the industry? In the latter event, are all firms better off than before the introduction of these practices, or do the benefits get passed on to the customers?

2.2. Internal perspective

The internal perspective considers the internal activities of a firm and views it as an organization of agents with uncertain and dispersed information and possibly different objectives. Broadly speaking, there are two key, inter-related issues to be considered: (i) the issue of coordination of decisions within the organization so as to make the best use of available information; and (ii) the issue of motivation and provision of incentives so that individual and organizational objectives are correctly aligned. The first issue can be viewed as an issue of organizational design, while the second can be viewed as an issue of human resource management. We discuss these in further detail.

2.2.1. Impact of organizational design

We are concerned here with the question of how organizational design influences the adoption and successful implementation of innovative OM practices. Among the issues that arise are the decisions that need to be coordinated and the organizational mechanisms that can be used to achieve this coordination. Economic frameworks like agency theory and transactions cost analysis (Jensen and Meckling, 1976) can be usefully applied to analyze many of these issues.

The popular business press suggests that most of the new OM practices require significant changes in the organizational design to facilitate their successful implementation. For example, Schonberger (1986) argues that implementing world class manufacturing practices requires "organizing for quick product flow and tight process-to-process and person-to-person linkages". However, the economic implications of such tight linkages have not been theoretically articulated.

The adoption of "mass customization", the ability to provide individually customized products at the same cost as standardized, mass-produced products, is another example of how organizational design plays a critical role in the successful implementation of an innovative OM practice. Pine et al. (1993) describe how mass customization requires a "dynamic network of relatively autonomous operating units" in the manufacturing plant's organizational structure, where each unit or module involves a specific process or task, and different modules interact in different ways for each customized product.

2.2.2. Human resource management

We are concerned here with the issues of selection and motivation of employees that an organization must consider in order to seek greater initiative and productivity from the employees in their tasks. A common theme in many of the new OM practices is to use groups or teams and encourage "worker empowerment" where workers are not only given ownership of their tasks but are also held accountable for their successful completion (Schlesinger and Heskett, 1991). This emphasis on participatory management has been motivated to a great degree by the success of Japanese firms in applying this approach to all levels of their organization.

What are the factors that lead to the successful implementation of these practices? Why is the system not undermined by individuals seeking to further their own objectives? Milgrom and Roberts (1992) argue that in the case of Japanese firms, factors such as lifetime employment, frequent job rotation, limited outside opportunities, narrow pay differentials and relatively homogeneous backgrounds all contribute to successful participatory management. Is it necessary therefore for U.S. firms to adopt similar practices within their organization? Or can such employee involvement be sustained in a more traditional U.S. organizational setting?

3. Major decision areas in operations

So far, our discussion has focused primarily on the different issues that must be considered in analyzing any OM practice. However, there are a number of distinct decision areas within OM, and many of the new practices that have been observed in industry have focused on a narrow range of activities within operations. Therefore, it is important for us to develop a classification of major decision areas within operations that can provide a framework within which to view the impact of these new practices.

Many classifications of OM decisions can be found in introductory texts on OM. We considered such classifications from five texts: (Chase and Aquilano, 1995; Dilworth, 1992; Heizer and Render, 1993; Schroeder, 1993; Stevenson, 1986). Consistent with these textbooks, we classify the key decision areas within OM into the following four broad categories:

(i) product design;
(ii) process selection;
(iii) production planning and control;
(iv) quality management.

While our classification seemingly emphasizes the key *tactical* decisions within operations, *strategic* decisions are also related to this categorization. Since operations strategy is a statement of what the production system must accomplish (Skinner, 1978), it will emphasize the key capabilities that need to be developed by the organization and these capabilities will necessarily affect all four of our decision areas.

In the remainder of this section, we proceed to elaborate on each of the four decision areas and discuss some major research issues that are amenable to theories and methodologies in economics.

3.1. New product design

Decisions involving new product design and development, while not completely in the domain of the operations function, influence and are influenced by operations decisions concerning process technol-

ogy, raw materials acquisition, and production control. Historically, in many firms in the U.S., the interaction between product design and manufacturing has been minimal. Product design and manufacturing have been viewed as sequential activities, with the result that the design process has tended to ignore potential manufacturing problems that arise as a result of the design decisions. As a result, changes are often required after manufacturing receives the design, thus increasing the time to market. In addition, suboptimal decisions tend to be made as manufacturing and design attempt to make either design changes or processing changes on a patchwork basis to solve the problems. Both cost and quality tend to suffer as a result (Dean and Susman, 1989).

As the basis for competition in many industries has evolved to emphasize time-based competition and high product quality, firms have focused on management practices such as "design for manufacturability" (e.g. (Dean and Susman, 1989)) to reduce development lead times and achieve high product quality in the manufacturing process. As Wheelwright and Clark (1992) point out, a firm that develops high-quality products rapidly increases its competitive options. It can introduce a product into the market faster than its competitors or it can delay its new product development process to acquire better market and technology information and introduce a new product at the same time as its competitors, but bring to market a product that is much better suited to customer needs. Activities that have become a well-accepted part of such practices include reducing the part count and using modular designs to simplify the manufacturing process and using computer-aided design/computer-aided engineering technologies to reduce lead times (Schonberger, 1986). In addition, cross-functional marketing-design-manufacturing teams are formed to ensure that design decisions are addressing customer needs and at the same time are congruent with manufacturing capabilities. This team approach has been referred to as "concurrent design" or "simultaneous engineering" (Whitney, 1988). Chrysler, for example, has used cross-functional "platform" teams, each team focusing on developing one line of cars or trucks. These platform teams have been very successful, reducing the time to market from 60 months in the 1980s to 31 months for the Neon, launched in January 1994 (Womack and Jones, 1994). The emphasis on design for manufacturability has reduced the time to paint, weld and assemble a product from 35 to 22 hours.

Impact of industry structure. What are the key industry-related factors driving a firm to adopt these new R&D practices? What industry conditions affect the effectiveness of these practices? Economic methods can help to gain insights into such questions both from a theoretical perspective, by developing formal models of competition, as well as by empirical analysis of observed firm behavior in different industries.

Another question that arises is how firms should allocate their resources between R&D and capital investment. What are the industry factors that affect such allocation decisions? In many Japanese manufacturing companies, for example, R&D investment is much greater than capital investment (Kodama, 1992).

Scope of competitive advantage. How can R&D activities provide a sustainable competitive advantage for a firm? As indicated above, the popular business press is replete with recommendations to pursue approaches such as design for manufacturability and simultaneous engineering that speed up the product development process and make it more effective in achieving cost and quality goals. What is less clear is whether these approaches are actually able to provide any long-term sustainable benefits to a firm. Stalk and Webber (1993), for example, describe a "dark side to time-based competition" in Japan in the early 1990s, where firms began to invest an increasing amount of resources to bring out more and more varieties of products without achieving any competitive advantage, higher margins or profits. They point out that many firms in Japan have now begun to cut back on the variety of their products. Japanese automakers, for example, have announced that they will be stretching their new product cycle from four to five years and are reducing the number of models they offer to customers (Stalk and Webber, 1993). Toyota has announced that it will reduce the number of Corolla models from 11 to 6. Nissan has announced that it will reduce the number of engines it offers by 40% over the next five years.

Another question of interest is whether firms face a trade-off when they seek both higher design quality and quick product designs. In some industries,

changes in technology have led to a clear emphasis on one dimension over the other. For example, Gross and Coy (1995) point out that design engineers of custom logic chips today have begun to emphasize quick designs over efficient designs since chips have become so small that compactness of design on a silicon wafer is no longer a critical success factor, but speed to market has become a key competitive weapon. How do different industries address this trade-off? Furthermore, what management practices are associated with minimizing such trade-offs?

Impact of organizational design. One of the key questions that arises in the area of product design from an organizational design perspective is how inter-functional design teams with design, marketing and manufacturing staff should be structured and rewarded. While the popular press has been nearly unanimous in promoting the use of such inter-functional teams, the potential organizational problems have received much less attention. Chrysler, for example, has discovered that many members of its platform teams have become anxious about their career path in the organization, given that these teams have very few layers of management (Womack and Jones, 1994). They are also worried about the dilution of their skills due to a lack of communication with functional colleagues elsewhere in the firm. What is required is a formal study of the key organizational changes that should accompany the successful deployment of such interfunctional teams.

Human resource management. What should be the incentive structure for inter-functional design teams? How can these incentives be structured to ensure that the product design achieves the desired goals of cost, quality, lead time and meeting customer needs. How should members of teams responsible for these activities be selected? These are some questions that need to be analyzed using the theories and methods of economics.

3.2. Process selection

Process selection decisions are concerned with determining the specifics of the transformation system to be used by the firm to convert its inputs into outputs. Broadly speaking, there are three inter-related decisions that are a part of process selection.

(i) Determining the organization of material flow. Hayes and Wheelwright (1984) identify four major process flow structures: job shop, batch flow, assembly line and continuous flow.
(ii) Determining the appropriate process technology mix.
(iii) Determining the location, design and layout of production facilities.

There are many new OM practices that address issues related to process selection. Computer-integrated manufacturing (CIM) and flexible manufacturing systems (FMS) have become significant aspects in the technology determination process. The advent of such "soft automation" offers the potential of producing large varieties of products in small lot-sizes at costs comparable to the traditional high-volume dedicated production lines.

Impact of industry structure. What are the key industry factors affecting decisions regarding process selection? In particular, what is the impact of the industry structure on decisions about investment in new technologies? For instance, Röller and Tombak (1993) study the impact of industry structure on investment in FMS. They develop a two stage oligopoly model of technology adoption that predicts market size and product differentiation as the key factors driving a firm to invest in FMS. They also present empirical support for their predictions.

Scope of competitive advantage. To what degree is investment in new technologies a key determinant of competitive advantage? Anecdotal evidence indicates that many firms are able to achieve industry leadership by investing in appropriate technologies rather than by investing in the latest technologies (Grant et al., 1991). For example, in the early eighties, the most efficient automobile engine plant in the world was Toyota's No. 9 Kamigo engine plant in Japan (McElroy, 1984), a plant equipped with twenty-year-old machines which had been meticulously retrofitted and maintained to achieve the highest levels of efficiency in the industry. In fact, Hayes and Wheelwright (1984) point out that in 1980, the majority of Japanese equipment spending was on upgrading the capabilities of existing equipment, while in the U.S., manufacturers spent an average of 75% of their capital investment on additional capacity and replacement of old machines. Rigorous empirical analysis is necessary to understand the key

industry factors that drive the use of new technology to gain competitive advantage. At the same time dynamic models of competition can help us to predict firm behavior in making new technology decisions and seeking competitive advantage.

How should new technologies be justified? A firm needs to determine the economic value of investing in new technology to decide whether the investment is worthwhile (Kaplan, 1986; Fine, 1993). Estimating this economic value requires addressing not only the obvious manufacturing cost issue, but also the strategic impact of the new technologies. For example, Haas (1987) describes a computer components manufacturer which invested $20 million in a flexible assembly system. The company found that the new system reduced manufacturing costs to such an extent that it paid for itself in a year. Strategically, however, the investment was even more attractive, since production times were cut by 80% and product quality was increased ten-fold, moving the firm from being an undistinguished to an outstanding manufacturer in its industry. Formal economic models will be useful in developing new methods for the justification of new technology that capture both cost and strategic issues (Lederer and Singhal, 1988). Empirical studies that consider different justification approaches in different industries, and the degree to which such approaches provide a competitive advantage will also help to enrich our understanding on this issue.

Impact of organizational design. What are the key organizational factors affecting the adoption of new technologies? Anecdotal evidence suggests that even leading firms can ignore emerging technologies, often with disastrous results. For example, in the computer industry, IBM misinterpreted the importance of the microcomputer, and delayed its entry into what became a lucrative market. From an operations perspective, it is important to understand what aspects of organizational design are key elements in making a firm respond quickly to changing product and process technologies.

Human resource management. How can managers be motivated to consider long-term benefits from new technologies versus short-term associated costs and risks? In many cases, it is easy for managers to become complacent and ignore technological changes, especially if the firm is a leader in its industry. As Bower and Christensen (1995) point out, the problem is especially acute when the emerging technology is "disruptive", that is, the new technology addresses customer needs that are quite different from those addressed by the existing technology. Since the new technology is of little value to existing customers, managers perceive the new markets as having very little potential and choose to ignore it. However, the new technology opens new markets and quickly becomes lucrative, thus resulting in the firm missing a profitable opportunity. How is the incentive structure for managers affected by an environment characterized by such rapidly changing technologies?

3.3. Production planning and control

Production planning and control decisions refer to medium-term aggregate planning and short-term scheduling decisions in operations. Many of the new practices in OM have been directed at making planning and control decisions more efficient and market-driven. Practices such as just-in-time production typically involve implementing a rate-based master production schedule that is used to drive a pull-based production system. In order to implement an effective pull-based system, it is necessary to reduce setup times and lot-sizes, as well as to ensure that machine-breakdowns are minimized by emphasizing preventive maintenance. Activities such as setup reduction and process improvement are driven by creating worker teams (with management support) and, therefore, just-in-time practices emphasize worker involvement. Finally, closer supplier relations are encouraged, since this allows the firm and its suppliers to work together to design component parts together and ensure high quality in their production. One manifestation of this effort is that many firms have moved towards having a single supplier for many of their raw materials and parts. Each supplier is given a long-term contract and provided technical and managerial support to improve its production process. Consider Chrysler as an example. According to Womack and Jones (1994), it has reduced its supplier base from 2500 in the late 1980s to 300. The suppliers are included in product development discussions and they provide input on design improvements and cost reductions. Rather than select-

ing suppliers through a bidding process, Chrysler selects its suppliers based on a broad set of criteria and uses target pricing for the final product to determine component prices and then works with the supplier on ways to achieve them. Most components are single-sourced for the life of the product.

This wide range of activities raises interesting research questions. We discuss some of these below.

Impact of industry structure. How are a firm's decisions regarding inventory and scheduling policies impacted by competitors' decisions? How are a firm's decisions concerning supply chain management impacted by competitors' decisions? In particular, how does competition affect the number of suppliers to a firm, the degree to which it seeks sole suppliers and the degree of vertical integration?

There has been some research to date in the operations management literature on the use of formal economic models to predict firm behavior on production planning decisions. Eliashberg and Steinberg (1991) study production and pricing strategies for two firms with asymmetric cost structures. Li (1992) considers the role of inventory in delivery time competition, using an *n*-firm market game. Li and Lee (1994) develop a duopoly model that focuses on a firm's decisions on price and delivery time performance.

Scope of competitive advantage. To what extent do just-in-time OM practices result in a reduction of trade-offs between the diverse objectives of minimizing cost, improving quality, reducing lead times and creating flexibility to respond to customer needs?

Do just-in-time practices provide a sustainable competitive advantage for a firm, or are these innovations quickly copied by other firms in the industry? In the latter situation, do these practices simply result in a change in the basis of competition in the industry without affecting the relative positions of the firms in the industry?

To what extent can supply chain management provide competitive advantage for a firm? What practices within supply chain management are associated with providing a competitive advantage? Dyer and Ouchi (1993) discuss some key differences in the way Japanese automobile firms manage their suppliers versus their U.S. counterparts. For example, they point out that American auto manufacturers are more vertically integrated than the Japanese firms with approximately 48% of parts manufactured internally, compared to 25% for Japanese firms. However, despite their greater degree of vertical integration, U.S. firms will contract with a greater number of suppliers than the Japanese, who tend to buy more, perhaps even entire subsystems, from a single supplier.

Impact of organizational design. A common recommendation in the popular business press for implementing just-in-time techniques is to use interfunctional teams on the production floor to address problems and seek continuous improvement. The implication of this recommendation is that organizations move towards a flatter organizational structure in order to successfully implement such practices. However, it is not clear that such flat organizations are always a prerequisite. Hayes and Pisano (1994) discuss the case of Allegheny Ludlum, a specialty steel manufacturing firm that has adopted many of the new OM practices but continues to maintain a primarily functional structure and involves top management directly on day-to-day issues, rather than seeking to solve problems at lower levels of the organization. Such anecdotal evidence suggests that an important area of research is the link between organizational design and the implementation of lean manufacturing techniques. Another interesting question is to what extent do specialization and job classification systems among workers impede the ability of the firm to implement the new OM practices.

Human resource management. How can a firm provide incentives to its suppliers to reduce costs, improve quality and adopt innovative OM practices that can be beneficial to both the firm and its supplier? U.S. automakers, for example, have not been as successful as their Japanese counterparts in getting suppliers to adopt lean manufacturing techniques (Womack and Jones, 1994).

How should workers on the production floor be motivated to ensure that their decisions are congruent with the overall objectives of the firm? In particular, worker teams implemented as a part of these new OM practices must address a variety of issues such as setup time reduction, detecting the source of quality problems, reducing machine downtime and worker cross-training. How should worker incentives be designed so that these continuous improvement

efforts are adequately addressed while meeting overall production goals?

One aspect of these innovative OM practices is that managers must increasingly play a supporting role that allows workers to address production problems directly. How should the incentives of managers be aligned with those of the workers to ensure that this support is in fact offered? This is particularly pertinent given that managers in such instances usually have short-term goals of meeting customer demand as well as long-term goals of improving productivity on which they are evaluated.

3.4. Quality management

The area of quality management is another area of operations decisions that has been dramatically affected by the renaissance in OM practices. The notion of "building quality into the product" as opposed to "inspecting quality into the product" is one key element of this new thrust. Another key element is that quality refers not only to external or customer-driven quality, but also to internal quality in the activities within the organization. As with many of the other new OM practices, this new emphasis on quality has been driven to a significant extent by the competition from Japanese firms in industries such as automobiles and consumer electronics. By reducing scrap and rework as well as by improving product design quality, these firms were able to compete effectively in the U.S. market by offering higher quality products at lower costs than their competitors. Thus, in the 1980s, many firms began to view quality as a strategic weapon and began to implement quality practices throughout their organizations, using approaches proposed by quality gurus such as Deming, Juran, Crosby, Taguchi and Feigenbaum. Formal tools such as statistical process control (SPC), pioneered by Shewhart have become standard mechanisms used by a firm in its drive to improve quality. Indeed, to emphasize its endorsement of quality as an integral element of success in business, the U.S. government instituted the Malcolm Baldrige National Award in 1987. Motorola won this award in the first year of its inception, 1988, and is estimated to have saved $6.5 billion in manufacturing costs since 1987 (The Economist, 1995).

The philosophy of seeking continuous improvement is another integral part of the new quality management practices. This perspective emphasizes that management should continually challenge the firm to achieve increasingly higher levels of performance in all aspects of the business. Moreover, continuous improvement will be driven by participative management so that all levels of the workforce are involved in this effort and decision-relevant information is provided to frontline workers (Melcher et al., 1990). In order to motivate the need for this improvement, firms can compare their performance on different dimensions with the best in the business. This benchmarking process has become a key component of the continuous improvement process.

The emphasis on quality is not limited to the manufacturing sector. As service operations continue to grow in importance, a variety of new OM practices pertaining specifically to quality management in service firms have become institutionalized. Predominant among these new practices is the renewed focus on the customer. Just as "zero defects" became a key driver for quality improvement in manufacturing firms, "zero defections", i.e. keeping the customer has become a pivotal driver of quality improvement in the service sector (Reichheld and Sasser, 1990). As Heskett et al. (1994) point out, the lifetime value of a loyal customer can be astronomical, especially when referrals and repeat purchases of related products are considered. Reichheld and Sasser (1990) estimate that a 5% increase in the customer retention rate can produce profit increases from 25% to 85%. It is not surprising, therefore, that many service firms are re-designing their service delivery systems to allow managers and workers to pay more attention to customer needs.

Impact of industry structure. What is the impact of the industry structure on the quality of a firm's product? To what degree does competitive intensity drive quality improvement within an industry? Banker and Khosla (1994) develop formal models of oligopolistic competition to study the effect of competitive intensity on decisions about quality levels. Their analysis shows that equilibrium quality and competitive intensity depends not only on the precise manifestation of increased competition, but also on the cost and demand characteristics in the industry.

An important element of the quality movement is

competitive benchmarking. Why should firms voluntarily share performance information with their competitors? Are trade associations or similar institutions valuable intermediaries for this purpose? Kirby (1988) presents some answers to these questions using an oligopolistic model of competition and information transmission. Elnathan and Kim (1995) further extend this analysis to provide predictions about the type and size of firms that will form into a cooperative group to share benchmarking information.

Scope of competitive advantage. What aspects of quality improvement efforts provide sustainable competitive advantage for a firm? It has been argued that achieving high quality is no longer a mechanism to seek competitive advantage, but rather a precursor to being competitive at all (The Economist, 1995). The sharp decline in the number of applicants for the Baldrige Award in 1994 has been viewed as a signal of the way in which quality is perceived as a competitive weapon. Rigorous empirical studies that are industry-specific can shed some light on how quality improvement efforts have evolved in their competitive scope.

Impact of organizational design. What are the key organizational factors that influence detailed understanding of the process, which in turn is a key driver of continuous improvement? Semiconductor companies, for example, are able to double their yield every three years or so. As Bohn (1994) points out, the incremental capital investment in such cases is usually minimal. Instead what drives the improvement are changes in the manufacturing process, brought about as the firm progresses further along its experience curve. Therefore, it is important to understand how organization design can affect a firm's ability to learn and its resultant rate of continuous improvement.

Human resource management. How can employees be motivated to strive to achieve the quality-related objectives of the firm? More specifically, how does a "top-down" management approach in quality improvement compare in performance to a more horizontal, worker-empowerment approach? IBM, for example, no longer has any formal stand-alone quality management programs (The Economist, 1995). Instead, the emphasis is that all corporate activities be infused with the notion of quality.

4. Conclusions

This paper has focused on the use of economic theory as an increasingly relevant tool for the analysis of operations management issues. The evolution of operations management has, over the last two decades, resulted in a number of new and innovative practices being adopted by firms in the U.S. Thus, it is appropriate that the research agenda in OM shift as well, directing its attention to which of these practices work well under what conditions, so that the findings of this type of research can guide firms in making improved decisions regarding the adoption and successful implementation of these practices.

In this paper we have argued that there are two key perspectives that must be considered in the analysis of any new OM practice.

(i) *External perspective.* This perspective considers the nature of competition in analyzing the adoption of new OM practices. We consider two broad categories of issues in this perspective. First, we consider the impact of industry structure on the adoption and implementation of these practices. Second, we consider the scope of competitive advantage provided by such practices.

(ii) *Internal perspective.* This perspective focuses on the issue of selection, coordination and motivation of employees within the organization. We also consider two key inter-related issues here. First, we consider the issue of coordination of decisions within an organization and the appropriate organizational design to achieve this coordination. Second, we consider the issue of selection, providing of incentives and motivation to individual employees, which we have referred to as human resource management.

We have considered the impact of these decision perspectives on four major decision areas within operations: product design, process selection, production planning and control, and quality management. For each area, we have discussed some key research questions that were highlighted by the different decision perspectives. Anecdotal evidence from the popular press was used to motivate the need for such inquiries.

In conclusion, our contribution here has been to posit that recent advances in the field of OM has

reinforced the need for new research perspectives that can enrich theory development. We believe that the research agenda in operations management can significantly benefit from new theoretical and methodological perspectives from the field of economics.

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