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# An Empirical Investigation of Quality and Productivity Management Practices in Manufacturing Firms

Kiran Vuppalapati

# AN EMPIRICAL INVESTIGATION OF QUALITY AND PRODUCTIVITY MANAGEMENT PRACTICES IN MANUFACTURING FIRMS

by

Kiran Vuppalapati

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Kiran Vuppalapati

# AN EMPIRICAL INVESTIGATION OF QUALITY AND PRODUCTIVITY MANAGEMENT PRACTICES IN MANUFACTURING FIRMS

Kiran Vuppalapati, M.S.

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A growing number of firms are implementing the concept of Just In Time (JIT) manufacturing and Total Quality Management (TQM). This research examines the impact of these management philosophies in manufacturing firms.

This research identifies a set of critical organizational variables necessary for a successful implementation and the organizational problems faced during their implementation. The major object is to test the performance of firms implementing both JIT and TQM against firms implementing none of these philosophies. Results show that JIT-TQM firms are more customer focused and have better employee relations than traditional firms. This study also compares the performance of JIT and TQM firms with JIT-TQM firms. Results show that JIT and TQM go together. There can be no JIT without TQM, and likewise.

Tests also show that the firms implementing JIT-TQM intensively have better supplier performance and overall performance than those firms implementing these strategies less intensively.

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# CHAPTER I

# INTRODUCTION

## Background

Just-In-Time (JIT) and Total Quality Management (TQM) are two innovative concepts which contribute substantially to high product quality and productivity [1] [4] [7] [9] [13] [14] [15] [18] [20] [21] [28] [30] [36] [37] [38] [43] [45].

These two management philosophies are being practiced in manufacturing firms all over the world. Intense competition and the realization of a global economy make it appear certain that during the next few years there will be an accelerated level of interest among many companies in the implementation of these concepts.

During the last two decades, practitioners and researchers who were concerned with product quality and productivity in the United States have focused increasing attention on the potential benefits of JIT and TQM. Today, a growing number of small and large U.S. companies have switched from traditional management practices to Just-in-time and Total Quality management concepts to improve their overall product quality and productivity. The benefits of JIT and TQM include improved quality, productivity, flexibility, customer satisfaction and reduced inventory, lead time, lot sizes and unit costs [2] [14] [18] [27] [30] [36] [38] [39] [41] [42] [44] [45].

Schonberger [39] categorizes these benefits into five groups: (1) parts costs-low scrap; (2) quality-fast detection; (3) design-fast response to engineering changes; (4) administrative efficiency-increased customer satisfaction; and (5) a productivity-reduced rework. Additionally, these two available concepts make it possible to capture and translate customer demands and expectations into the process of designing an efficient management system.

Thus, it is not surprising to see significant efforts on the part of manufacturing companies to improve their product quality and productivity through these practices.

## Purpose of the Study

Many companies have realized the great potential of improving product quality and productivity through the implementation of Just-in-time and Total Quality Management. Using these concepts both the customers and suppliers benefit because the system will lower costs, improve quality and raise productivity.

The purpose of this study can be summarized as follows:

1. Recent literature on the above mentioned concepts suggest that their benefits are substantial as compared to the traditional management system. Empirical research is needed to support that contention.

2. It is important to analyze the critical variables that are conductive to a successful implementation of Just-In-Time and Total Quality Management.

3. Finally, it is important to identify key organizational problems that companies typically encounter when implementing these concepts.

## Research Proposition

The research proposition that this thesis addressed is primarily: (1) whether the performance of firms implementing both JIT and TQM is better than the performance of firms not implementing any of these strategies; (2) whether the performance of firms implementing JIT is better than the performance of firms implementing both of these strategies; and (3) whether the performance of firms implementing TQM is better than the performance of firms implementing both of these strategies.

This research also tested whether the performance of firms implementing both JIT and TQM intensively is better than the performance of firms implementing both JIT and TQM less intensively.

## Research Methodology

The methodology employed consisted of a cross sectional field survey of 285 companies in the West Michigan area. Data were collected from quality/production managers, plant/facility managers or the director/vice president of quality /manufacturing.

The data collection methodology consists of responses from questionnaires. This questionnaire was used to collect data from 6 categories: (1) company descriptions; (2) supplier related; (3) internal manufacturing; (4) quality related; (5) performance indicators; and (6) implementation problems.

Table 1

Overall Organization of the Thesis

| Chapter | Contents |
|---|---|
| I | Introduction to the Study<br>Purpose of the study<br>Research Propositions<br>Research Methodology<br>Organization of the Study |
| II | Review of Present Literature<br>Overview of the JIT Concept<br>Overview of the TQM Concept |
| III | Research Methodology, Propositions and Research Procedures, Questionnaire Design, Presentation and Analysis of Data |
| IV | Summary and Conclusions |

## Organization of the Thesis

Table 1 and Figure 1 present an overview of the thesis. Chapter I of this thesis serves as the introduction to the entire study; Chapter II will provide an overview of the Just-In-Time and Total Quality Management concepts and discuss major issues as currently presented in the literature; Chapter III describes the research methodology employed to investigate the elements of Just-In-Time and Total Quality Management and its impact on overall performance. The methodology and questionnaire design employed in this study are discussed in detail. This chapter will be concluded with the presentation of summaries of data analyses; Chapter IV

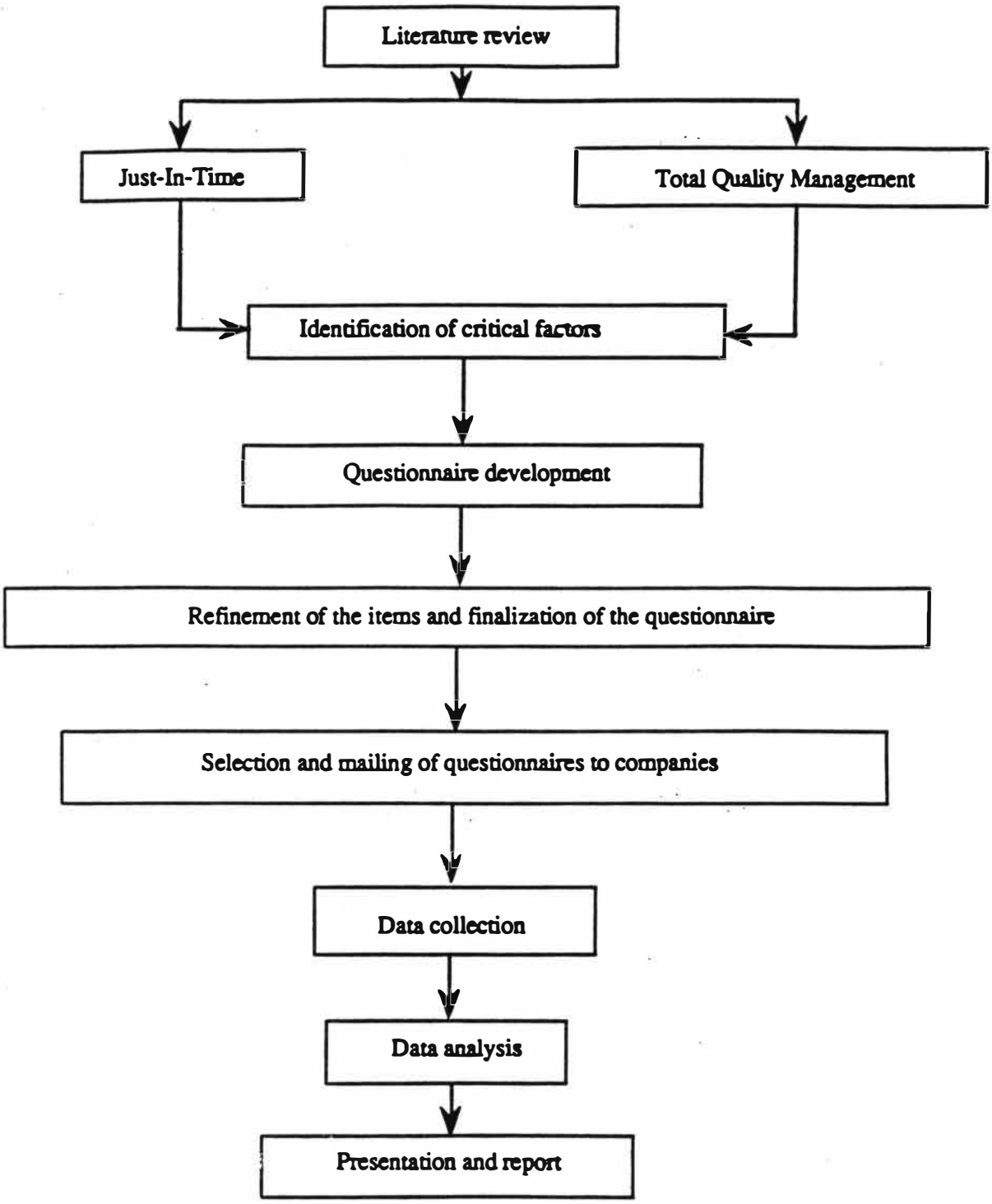



Figure 1. The Thesis Research Process.

provides the summary and conclusion. Suggestions for future research are also presented in this chapter.

# CHAPTER II

# LITERATURE REVIEW

This chapter is devoted to a discussion of the literature pertaining to Just-In-Time and Total Management Practices. The first part deals with Just-In-Time and the second part deals with Total Quality Management. It covers the philosophies, the principles, and the components and elements of these concepts.

## An Overview of the Just-In-Time Concept

The success of the Japanese in manufacturing and marketing a wide range of high quality products at very competitive prices has been mainly attributed to their ability to develop and adopt effective production techniques, of which Just-In-Time is perhaps the most widely discussed [11].

A Just-In-Time system is a complete system designed for efficient quality production [28]. It is geared to the production of a large variety of products. According to Ohno [32] the originator of Just-In-Time, this system works efficiently under a variety of economic conditions. It works during low growth periods and even better during high growth periods, when most companies are striving for mass production of a number of different products. He defines Just-In-Time as having the right part at precisely the right time, and in the right quantity, to go into assembly.

In JIT, a downstream section will pick up the items needed from an upstream

section. In traditional practices an upstream section typically makes some lots of items and sends them to the next section (downstream), whether the downstream section needs them or not, resulting in a stock pile of inventory. This approach causes waste of time and effort on the part of downstream workers since they will be responsible for handling items which, at the time, maybe of no use to them.

Schonberger's [36] definition of Just-In-Time explains this idea in an excellent way. He states that the goal of JIT is to produce and deliver finished goods just in time to be sold, sub-assemblies just in time to be assembled into finished goods, fabricated parts just in time to go into sub-assemblies and purchased materials just-in-time to be transformed into fabricated parts.

Principles of Just-In-Time : The Just-In-Time concept includes the following principles which guide quality and productivity improvement activities [44]. They are: (a) Produce to exact demand, one unit at a time; (b) Eliminate waste; (c) Achieve continuous improvement; (d) Allow for no contingencies; (e) Respect people; and (f) Provide for long term emphasis.

The first principle states that for the exact quantity delivered to the proper place when needed, but not before needed, the quantity being produced must match that quantity which is needed. This means the production rate must equal the demand rate. The simplest way to do that is to produce the part next - which is needed next - for the next stage in the manufacturing process. A simpler way to rephrase it would be to produce a quantity of one to match the quantity of one being used next [35]. This means that no process for any reason is allowed to produce extra amount and

have surplus stock between the processes. Therefore each process must approach the condition where it produces only one piece corresponding to the single unit that is coming off the final assembly line. This requires organizing the shop to place emphasis on flexibility, short runs, and minimum notice time from the customer. Premium must be placed on the responsiveness, flexibility, reaction to short lead time and the physical linkage needed to achieve the ideal balance and synchronization.

In Just-In-Time waste is anything more than the minimum amount of plant, equipment, materials and workers absolutely required for production. Waste exists in many forms, some of which are easy to detect and correct, but the subtile hidden forms are very difficult to uncover. The idea is to uncover and eliminate as many kinds if waste as possible. This principle aims at eliminating waste exemplified by excessive lot sizes, quality rejects, machine breakdowns and excessive transit time for work in process.

Taiichi Ohno, an early developer and advocator of JIT practices at Toyota, identifies the seven wastes in production (Table 2) as [32]:

1. Over-production: This waste can be eliminated by reducing setup times, compacting layout and improving shop floor visibility. Make only what is needed now.

2. Waiting: Synchronize work flow and balance loads through flexible workers and equipment.

3. Transportation: Establish layouts to eliminate transport and handling. Rationalize transport that cannot be eliminated.

Table 2

Different Kinds of Waste

| Item | Identification |
|---|---|
| 1 | Waste arising from over production |
| 2 | Waste arising from time on hand |
| 3 | Waste arising from transporting |
| 4 | Waste arising from processing itself |
| 5 | Waste arising from unnecessary stock on hand |
| 6 | Waste arising from unnecessary motion |
| 7 | Waste arising from producing defective goods |

4. Processing: Use value analysis.

5. Stocks: Reducing all other wastes reduces the waste of stocks.

6. Motion: Study motion for economy and consistency. Economy improves productivity, consistency improves quality.

7. Making defective products: Build processes to eliminate defectives. Do not send defects for further processing until corrected.

Just-in-time emphasizes the fact, that the process of improvement needs to be continuous. Here perfection is the goal. The key is constantly examining the process and asking " Why does it have to be that way ?". Attention must be paid to detail, attacking the process head on questioning each and every step. It is not only important to look for big improvements that could save large amounts of money, but

also the little improvements that add up to big savings and big improvements. The process of improvement should constantly be on the move. The central unifying concept is the idea that everything a firm does is a part of a continuous improvement process. This is a fundamental principle under which quality and productivity improvements are considered. Therefore in JIT there is a demand for continuous improvement. Improvements may be in several areas like, reducing errors and defects, reducing waste, improving responsiveness and cycle time performance or improving the efficiency and effectiveness of all resources.

A straight forward improvement model (figure 2) is the Deming-Shewhart PDCA cycle of Plan, Do, Check and Act. The steps in this continuous improvement

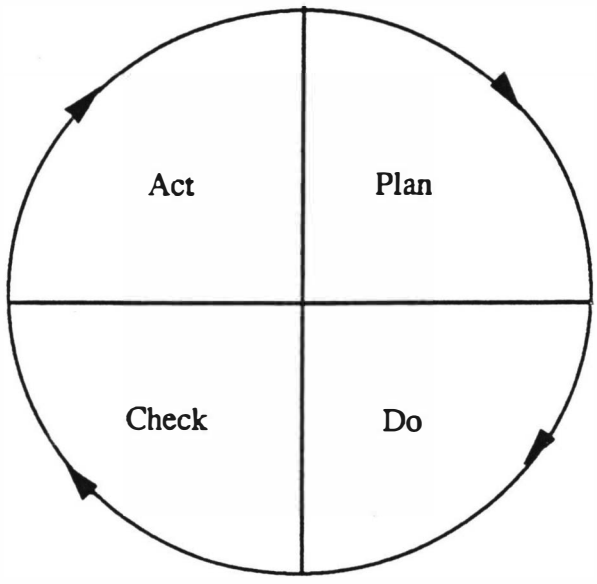



Figure 2. The Deming-Shewart Cycle for Continuous Improvement.

process are:

| | | |
|---|---|---|
| P for Plan | - | Choose an area for improvement |
| | | Collect data |
| | | Establish an action plan for change |
| D for Do | - | Execute the action plan/change |
| C for Check | - | Check and study the results |
| | | Action/change implemented |
| A for Act | - | Evaluate the results |
| | | Determine what was learned |
| | | Identify the next area for improvement and recycle back to P. |

The Just-in-time system calls for an organization that is so finely tuned that there is no margin for error. Although the aim is to eliminate waste, the need for a little insurance to be on the safe side is felt. This forms the basis for the traditional Just-in-case practices, which is intolerable in JIT.

A Just-in-time system recognizes that people are the source of improvements. Traditional practices of management are replaced by a new set of values by providing a stable environment, the motivation to help contribute the workers ideas to the organization and most important giving them the respect the deserve. The fact is that, the most under developed source of potential is the shop floor where almost 80% of the personnel spend almost 99% of their time. Therefore Just-in-time emphasizes a rethinking of traditional processes and practices since these are the people who will be the major source of quality and productivity improvement ideas.

Quality and productivity improvements to be successful must be implemented on a comprehensive and long term basis. The effort to improve quality and productivity must be continuing and consistent over time. The JIT approach is one which when implemented yields significant long term continuous improvement in performance. Companies should therefore focus not on seeking short term break-through's but long term improvements to realize the maximum benefits of JIT. Implementing JIT means traditional companies must revolutionalize their management culture. An environment must be created where management listens to employees and customers. Employees must be empowered and given the responsibility to take corrective action in their areas of activity. A culture must be created where employees are fully involved and value team work. The previous principles say to produce to exact customer demand with a lot size of one, to eliminate all waste in the system and to implement a philosophy of continuous improvement. Accepting these principles means emphasizing on the final principle of JIT and that is long term emphasis.

## Components of Just-In-Time

Each of the components of the JIT (Figure 3) philosophy is designed to eliminate or, at least, reduce a source of system variation [5]. For example; the pull method of production simply means that material is drawn or sent for by the users of the material as needed [17]. This element is required in a Just-in-time operation to reduce inventory and synchronize the movement of materials so that operations will complete work at the same rate.

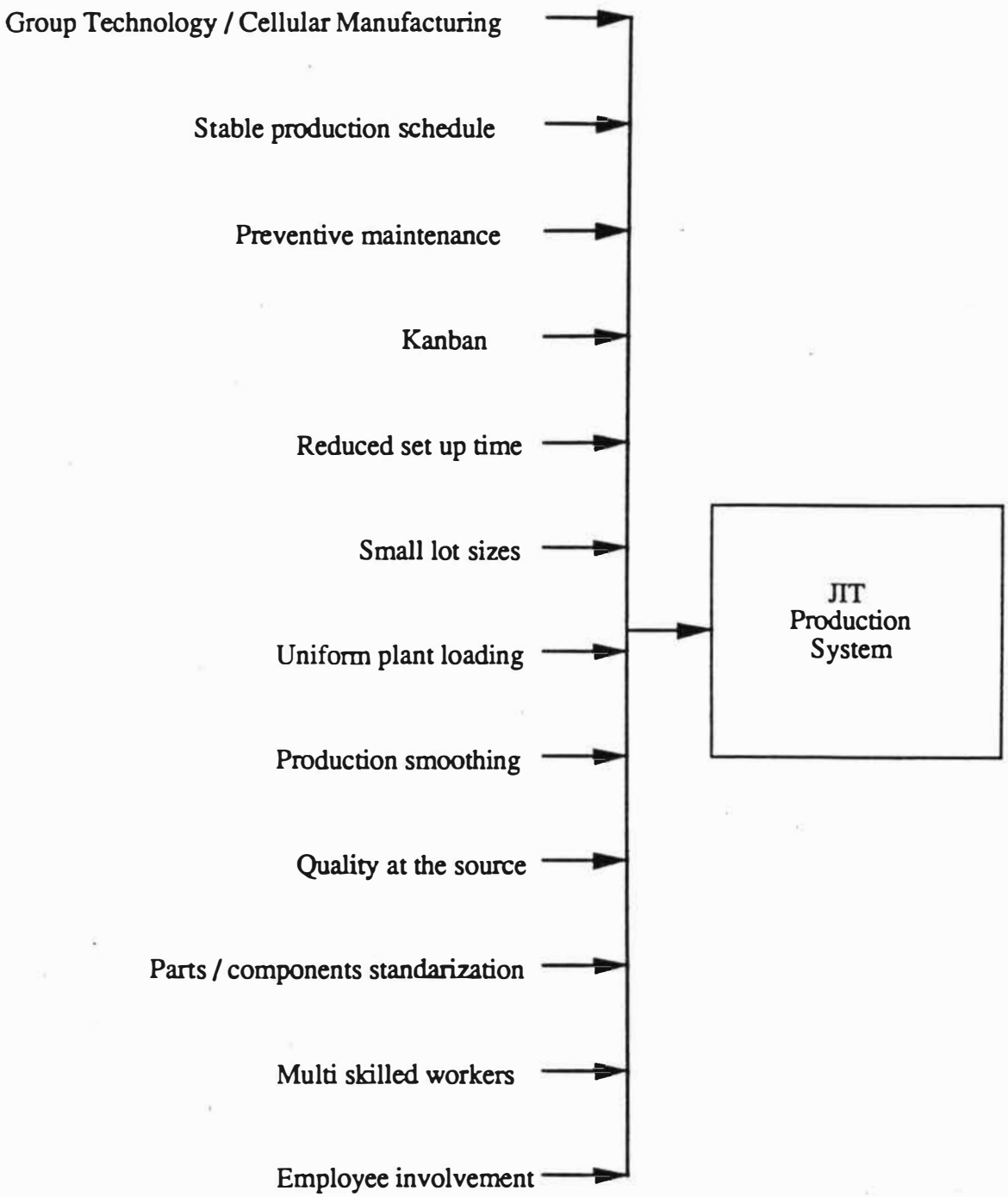



Figure 3. Components of Just-In-Time production system.

If the work areas are to be synchronized, process changes such as Quality at the source/worker centered quality control are needed to assure that materials move through the facility at the same rate. The precise rate of movement cannot include time for rework; continuous identification and elimination of process and product defects are a necessity.

To avoid unexpected delays due to malfunctioning equipment, preventive maintenance also is required in a Just-in-time operation to ensure that equipment is available when needed.

Another component of the Just-in-time philosophy is plant reorganization. Equipment or operations required for similar parts or products should be grouped together. This reorganization can include the development of manufacturing cells or group technology cells. Group technology is the arrangement of equipment of different types in one area to facilitate the existing manufacturing process. By putting the equipment in a "line" and in the order that will be needed to complete the steps of manufacturing that must be carried out on a given part, several kinds of efficiencies are gained. One operator who is cross trained can run the whole group of equipment. It also reduces work in process inventory and reduces lead time to a minimum through overlapped operations [5].

By maintaining a level schedule, reducing setup time and reducing lot sizes variation can be reduced. A level schedule is one that requires material to be pulled into final assembly in a pattern uniform enough to allow the various elements of production to respond to pull signals [18]. Small lot sizes are needed to maintain a

level flow of materials. Because excess inventory is not available, reduced lot sizes also encourage workers to identify and eliminate causes of poor quality. Short set up times are required to increase the number of set ups, decrease lot sizes and increase flexibility. This also helps to achieve smoothing of production.

Employees who work with a process are familiar not only with the operation, but also the weaknesses and problems present in the operation. Their input must be considered when identifying causes of process problems and variation. Small group improvement activities provide one way of encouraging production workers to take part in the improvement process. These activities include but are not limited to quality circles and suggestion programs that are organized by the employees.

Employees must also develop the skills needed to operate different machines or complete different tasks. The benefits of this development are two fold. First, multi skilled employees are better able to identify and solve process problems because of their understanding of the various aspects of the manufacturing facility. Second, maintaining the needed constant production rate requires process flexibility. Delays in one area eventually effect completion dates in subsequent work centers. Therefore, it is important that managers have the capability of shifting employees to work centers experiencing delays - multi skilled employees provide this flexibility.

Standardization leads to a more uniform, invariable output rate. Standard cycle times, standard routings, standard containers and holding a fixed quantity of work in process are features of standardization. These features help to achieve a minimum amount of work in process which is a JIT goal.

Uniform loads minimize production for stock. If customer orders are equal to the uniform load, then they must be made everyday. Customer orders over uniform load are moved to the next day or days. Some production to stock is required when customer orders are below uniform load. In planning and execution, uniform load must be strictly adhered to. Changes maybe made if market demand changes permanently. When demand is highly seasonal, stocking some finished goods rather than seasonally adjusting the work force is feasible [6].

The Just-in-time production is highly dependent on a production flow of parts without delay. It is therefore important that no defective parts are produced. Without buffer inventories available for production disruptions, any disruption caused by defective parts production could create havoc. Poka-yoke is a technique for avoiding simple human error at work, thus avoiding the production of defective parts caused by worker error [33]. For example; a line producing products can have small and simple devices designed to either stop the line before a defect occurs or signal an operator to come quickly to examine a potential problem. These sensors can be lined up to inspect 100 percent of the work. Every single operation can be checked before it is moved on. These checks normally help detect errors before a defect can occur.

Just-in-time production process is accomplished by a pulling process of production control. In the pull system of production control, each preceding process draws just the right amount of inventory from its respective preceding process in order to keep going. This practice continues right down to the raw material stage, or in the case of purchased parts or sub-assemblies, down to the parts or sub-assembly delivery

stage. A method used to control the movement of parts is Kanban. Kanban means a tag or card which is attached to a container of inventory or to a group of parts or sub-assemblies [26]. In short the term Kanban is a means of communication.

The use of Kanban is essentially a production management information system through which the pull system of production control is accomplished. Kanban cards are basically of two kinds. One is called the production order Kanban or production Kanban. The other is called withdrawal Kanban. The production Kanban authorizes the preceding process to produce the number of parts or sub-assemblies that are listed on the Kanban. By using standard containers, the authorized production is usually determined by the capacity of the container used. The withdrawal Kanban is attached to a parts container when it is removed from the preceding operation and transported to the next operation. As the withdrawal Kanban is attached to the container, the production Kanban is removed from the container and it becomes authorization to the preceding process to produce another container of parts or sub-assemblies .
Thus the inventory between two succeeding operations is controlled by the number of production and withdrawal Kanbans allowed to exist between the two succeeding operations.

Supplier involvement is a important element of a JIT system. Accelerating adoption of new strategies has led to a change in supplier manufacturer relationships. The traditional supplier criteria of "low bidder" is expanded to include the requirement that suppliers adopt new strategies such as JIT. Thus, there is a multiplier effect as suppliers and their suppliers are required to adopt these strategies.

The fact that purchased material from suppliers account for fifty percent or more of the total costs and has a great influence on the final quality of the manufactured products provides a view of the importance of suppliers. Buyers in a JIT environment should move to a system of certifying and validating suppliers. Criteria for selection and certification may vary, but should include quality, their capability to adopt programs that ensure the quality of their products and to provide evidence that quality is achieved. Price and their ability to supply frequent shipments, preferably in small amounts as and when needed are also important criteria.

## An Overview of the TQM concept

No management issue since the Scientific Management movement of Frederick Taylor in 1907 has had the impact of the Quality movement [20]. The concern is understandable. External competition has been threatening many U.S. firms and the quality or the lack of has many times been cited as an important reason why people buy foreign products.

One promising development is the growing acceptance of Total Quality Management ( TQM ) as a way of company life. TQM includes all functions of the business and is the integration of these functions and related process into the product life cycle such as design, planning, production, distribution and field service. Properly defined "TQM is a management philosophy and a set guiding principles, practiced with a range of tools and techniques that seek continuous improvement in the quality of performance of all the processes, products and services of an organization,

spreading the message that quality for the customer is the basic aim and that the way people are expected to deal with problems are determined by what will support and sustain this basic aim" [14] (Fisher, 1991, p. 150).

This section of the chapter examines the quality management approaches of the world's most influential theorists on the subject; W. Edwards Deming, J.M. Juran and Philip Crosby. The rationale for choosing these three quality theorists/consultants is due to the fact that American industry and academics alike identify these three as the "gurus" of the quality revolution. In addition, they are widely acclaimed as individuals who affect the management of the quality function in U.S. manufacturing.

## The Deming Approach to Quality Improvement

W. Edwards Deming was originally trained as statistician. He began teaching statistical quality control in Japan shortly after the end of World war II and he is acknowledged as an important contributor to the Japanese ascendancy in Quality Management. In recognition of his contribution to the Japanese economy, the Union of Japanese Science and Engineering ( J U S E ) instituted the highly prestigious Deming prize, awarded annually to the Japanese firm that demonstrates the most advancement of precision and dependability of product.

Deming focuses on the improvement of product and service conformance to specification by reducing uncertainty and variability in the design and manufacturing process. To achieve this, he advocates a never ending cyclic process of product design, manufacture, test and sales, followed by surveys and then redesign,

manufacture, test, sales repeating the cyclic process.

Deming claims that higher quality leads to higher productivity which leads to long term competitive strength. The objective of the firm should be "to stay in business, to protect investment, to earn dividends, and to ensure jobs and more jobs" [8] (Crosby, 1979, p. 196). Long term survival of the firm, not quarterly profit increases is paramount. He believes that improving quality provides the best path for meeting these goals.

Deming stresses that the top management of the firm has the overriding responsibility for improving quality. Both Deming [9] and Juran [21] believe that most (approximately 80 - 85%) quality problems are management controllable, not worker controllable. Therefore, blaming quality problems on workers who have no power to change the system is at best useless and probably counter productive.

The methodical core of Deming's approach to quality improvement is based on simple statistical techniques. He proposes that every employee in the firm be familiar with elementary Statistical Quality Control techniques such as pareto analysis, cause and effect diagrams, histograms, control charts and scatter plots. All employees should use these techniques to analyze their own work for improvement opportunities.

Deming identifies two sources of improvement of processes: eliminating common causes of quality problems and eliminating special causes of quality problems. Common causes are problems that are systematic. Examples of these are poorly designed products, inadequate training programs, improper bills of materials and uncomfortable working conditions. Common causes can only be corrected by

management. Special causes are problems that are identifiable with a specific individual, batch of materials, or machines. Statistical quality control techniques are useful for distinguishing between common causes and special causes, and for providing insight into how to eliminate the causes of quality problems.

Deming's fourteen point program, chronicled in chapter II of his book, constitutes the core of his recommendations to management for achieving quality excellence. These steps are aimed at creating an organizational environment in which statistical methods will be effective. In them, he prescribes strong management commitment to quality, process design and control through statistical methods, continuous search for and correction of quality problems and a purchasing policy that emphasizes quality rather than cost. Further, he prescribes the removal of all barriers to employee participation and teamwork. He stresses effective communication between supervisors and employees and company wide training and education in quality. While not strongly reflected in his fourteen principles, Deming's writings [8] [9] [10] also address the importance of product design and quality information systems.

Deming's 14 step process for quality improvement are:

1. Create and publish to all employees a statement of the aims and purposes of the company. The management must demonstrate constantly their commitment to this statement.

2. Learn the new philosophy, top management and everybody.

3. Understand the purpose of inspection, for improvement of processes and

reduction of cost.

4. End the practice of awarding business on the basis of price tag alone.

5. Improve constantly and for ever the system of production and service.

6. Institute training.

7. Teach and institute leadership.

8. Drive out fear. Create trust. Create a climate for innovation.

9. Optimize towards the aims and purposes of the company, the efforts of teams, groups and staff areas.

10. Eliminate extortions for the work force.

11.a.Eliminate numerical quotas for production. Instead learn and institute methods for improvement.

11.b.Eliminate M.B.O. Instead, learn the capabilities of processes, and how to improve them.

12. Remove barriers that rob people of pride of workmanship.

13. Encourage education and self improvement for everyone.

14. Take action to accomplish the transformation.

The Juran Approach to quality improvement

Joseph M. Juran has probably contributed as much to the field of quality control and management as all other contributors combined. His quality control handbook is widely read by quality professionals and he has authored or co-authored ten books. Dr. Juran taught quality management principles to the Japanese in 1950's

and still teaches legions of managers and professionals throughout the world.

Juran defines the quality mission for management on two levels. The mission of the firm as a whole is fitness for use by customers. Fitness for use is determined by a product's design, the degree to which the product conforms to the specifications of that design, the product's availability, reliability and maintainability, and the field service that accompanies the product. The missions of individual departments in the firm are to work in accordance with specifications designed to achieve fitness for use.

Juran describes the process of achieving fitness for use as a perpetual spiral of activities that include market research, product development, design, planning for manufacture, purchasing, production process control, inspection and test, and sales followed by customer feedback through market research which begins the spiral over again. Each of the functions in the spiral makes use of a body of specialized technical knowledge and specialized quality related knowledge. Because each of these functions play a crucial role in the achievement of fitness for use, and because these functions are highly interdependent, Juran sees a great need for competent, company wide quality management.

In Juran's view a firm's senior management must play an active and enthusiastic leadership role in the quality management process. Top management must assure that it is common knowledge in the firm that quality improvement is a continual, ongoing, everlasting process. To help communicate this message, top management should play an active hands on role in establishing the firm's quality policies, goals, plans, organization measures, controls and training programs.

Juran's approach to quality management focuses on three major quality processes: quality control and the quality sequence, quality improvement and the breakthrough sequence, and quality planning and the annual quality program. The control sequence is designed primarily to attack sporadic problems (analogous to Deming's special causes). The breakthrough sequence attacks chronic problems (common causes) and the annual quality program institutionalizes managerial control and review over the quality management process.

Sporadic problems should be attacked through the quality control process. Quality control is defined as "the process through which we measure actual quality performance, compare it with a standard, and act on the difference" [21] (Juran, 1970, p. 53). Tools for attacking sporadic problems include tolerance reviews, fool proofing, and standard statistical process aids such as frequency distributions, histograms and control charts.

To achieve the breakthrough in quality and solve chronic problems, Juran advocates the use of a three step " universal " process. The steps are: (1) study the symptoms, (2) diagnose the causes, and (3) apply remedies. To institutionalize continual quality improvement firms should adopt this process for a vast array of quality improvement projects.

Project-by-project improvement is a corner stone idea in the Juran quality improvement philosophy. At every point in time, hundreds of quality improvement projects, each tackled by a quality project team, should be underway throughout the company. Projects can address issues in manufacturing, engineering, marketing,

employee relations, vendor relations, quality training, or any other area where improvement is desirable. Juran strongly advises that top management get involved in some projects in order to display leadership and support for quality improvement projects and as a way to improve their understanding of quality.

The breakthrough sequence [21] aids in attacking chronic quality problems. Reduction of chronic problems (long standing adverse situations) requires a managerial breakthrough comprised of two parts: a breakthrough in attitude followed by a breakthrough in knowledge.

The annual quality program is an important vehicle for quality planning and for top management involvement in the quality management process. In Juran's view, the strategic planning system for quality should be similar to a firm's financial planning system. The planning process determines short term and long term goals, sets priorities, compares results with previous plans, and meshes its plans with other corporate strategic objectives.

Training in the quality disciplines is another cornerstone in the Juran philosophy. The quality disciplines contain a body of knowledge crucial to " modern competition in quality " [21] In Juran's classification scheme, the quality disciplines consist of knowledge in the major managerial quality oriented concepts as well as tools for specific sectors of the spiral, for quality improvement and cost reduction, for management of the quality function, and for data collection and analysis. Juran's organizational requirements for effective quality management are:

1. Establish corporate quality policies.

2. Establish corporate quality goals; review quality goals of divisions and major functions.

3. Establish corporate quality plans; review divisional and functional plans.

4. Provide the infrastructure and resources needed to carry out the plans.

5. Review quality performance against plans and goals.

6. Revise the managerial merit rating system to reflect performance against quality goals.

## The Crosby Approach to Quality Improvement

Philip B. Crosby, author of Quality is Free and Quality without tears, developed the zero defects program and founded the Crosby quality college. He was corporate vice-president for quality at ITT for fourteen years, after working his way up from line inspector.

The essence of Crosby's quality improvement process is embodied in what he calls the Absolutes of quality management and the basic elements of improvement. The absolutes address the question of what quality is and what standards and systems are needed for the achievement of quality.

The first absolute of quality management is: the definition of quality is conformance to requirements. Requirements setting is the responsibility of the management. Requirements are communication devices; they tell employees, vendors and customers what to expect and what to do in a wide variety of circumstances. All employees should "perform exactly like the requirement or cause the requirement to

be officially changed to what we and our customer really need" [7] (Crosby, 1979, p. 93).

The second absolute of quality management is: the system for causing quality is prevention. The first step towards defect and error prevention is to understand the process by the process by which the firm's product or service is produced. Once this is done, the objective is to discover and eliminate all opportunities for error. One way to do this is by monitoring the process and learning to anticipate errors before they occur. Control charts are one example of this approach. When a defect or error does occur, the discovery and elimination of the cause becomes a top priority item. This prevents the second and all subsequent occurrences of the problem.

The third absolute is: the performance standard is zero defects. Crosby feels that this absolute is widely misunderstood. Crosby claims that most people accept zero defects as a performance standard in many aspects of the personal lives and only need to be taught and convinced that it is a reasonable, and in fact, essential standard in their work lives. Most people cannot and will not live with a two percent AQC (acceptable quality level) with respect to the accuracy of their paychecks or the number of typographical errors in correspondence that goes out under their names. Errors in paychecks are not shrugged off by the recipients. Rather, the source of the defect is sought out and solved. Further, whenever possible, the system is adjusted to prevent the recurrence of the error. This is the essence of the zero defect idea. Error is not inevitable and non conformance is not inevitable. AQL's send the wrong signals to the workers, suppliers and customers; therefore zero defects should become

the personal performance standard of every one in the firm.

The fourth absolute of quality management is : the measurement of quality is the price of non conformance. Data on the cost of poor quality is useful for three reasons: (1) to call management's attention to the financial magnitude of the firm's quality problems, (2) to discover and select lucrative corrective action opportunities, and (3) to track quality improvements and its financial impact over time.

Crosby's basic elements of improvement include determination, education and implementation. Determination means that top management is serious about quality improvement. Determined companies have these five characteristics in common:

1. Quality improvement is an ongoing, everlasting process.
2. Quality education and philosophy begins at the top of the organization.
3. Quality control departments believe in zero defects.
4. Quality training materials and instruction must be excellent.
5. Management is patient and never decreases effort or enthusiasm for quality improvement.

With respect to education, the absolutes of quality management should be understood by everyone. They are the common language of the firm. Furthermore, every individual in the firm must have a well defined role with respect to quality and must understand that role. In addition, every member of the management team must understand fully the fourteen step process for implementing quality improvement.

Relative to Deming and Juran, Crosby places a strong emphasis on the process of changing the corporate culture and attitudes. His fourteen step process gives clear

guidance for building a quality improvement attitude in the organization. Conversely, Crosby places little emphasis on statistical quality control techniques relative to Deming and Juran.

With respect to the role of quality professionals in the organization, Crosby recommends that the quality organization exists "to the degree necessary to ensure that the acceptance and performance standards for the firm's products are met and to ensure that the cost of quality goals for each operation are achieved" [7] (Crosby, 1979, p. 38). Quality departments should "measure and report conformance, demand corrective improvement, encourage defect prevention, teach quality improvement and act as the conscience of the operation" [7] (Crosby, 1979, p. 41).

Active top management participation is crucial to Crosby's process. Believing that workers performance reflects the attitude of the management, Crosby demands that all managers adopt zero defects as their personal standard of conformance.

Crosby believes that since workers performance reflects the attitudes of the management, a quality improvement program should be directed first at management. However hourly workers do play an important role in the zero defects planning, corrective action and goal setting.

Crosby's fourteen steps towards quality improvement are as follows:

1. Top management must be convinced of the need for quality improvement and must make its commitment clear to the entire company.

2. Form a quality improvement team.

3. Establish measures for quality improvement.

4. Conduct cost of quality evaluations.

5. Raise quality awareness among the employees.

6. Generate opportunities for corrective action.

7. Quality improvement team must plan for zero defects.

8. Train supervisors and all levels of management early in this process.

9. Schedule a zero defects day.

10. Set measurable goals.

11. Error cause removal.

12. Recognition should be given to those who meet their quality goals.

13. Quality councils should meet regularly to share experiences, problems and ideas.

14. Do it all over again.

Much has been written about how quality should be managed in an organization. Deming [9] [10] [11] recommended fourteen principles for effectively managing quality in the organization. Juran [21] [22] [23] [24] [25] discussed the three basic processes of quality management: quality planning, quality control and quality improvement. Crosby [7] [8] described a fourteen step zero defect quality improvement program for the organization. In their prescriptions for quality management these and other authors [3] [13] [14] [15] [16] [17] [20] [29] [34] [40] [43] [45] repeatedly discuss the importance of such critical factors as top management leadership for quality, supplier quality management, process management, employee training and employee involvement in quality. The literature implies that as the

decision makers of an organization focus on better management of such critical factors, improvements will occur in quality performance and ultimately result in improved financial performance for the organization.

This research, based on a review and synthesis of the quality literature identifies seven critical areas of managerial planning and action that must be practiced to achieve effective quality management in a business unit. The factors or elements were derived through a process that involved identification of those critical requirements for quality management that have been prescribed by eminent quality practitioners and academics.

The seven categories identified were also based on the Malcolm Baldrige National Quality Award criteria. Twenty seven organizational requirements for effective quality management were generated for these seven categories. Through a judgmental process of grouping similar requirements , they could all be classified into these seven separate categories. Each of the seven categories and their elements are supported by all of the authors and together they define the important aspects of quality management practice. The categories and their elements are described in Table 3.

While the proposed elements are literature based, they can be validated by empirical research. Also while it is certainly true that other sets of categories could be identified differently, this set appears to capture most of the important aspects of effective quality management as espoused by today's leading practitioners and

Table 3

Critical Factors of Quality Management

| Critical Factors of Quality Management | Explanation of Critical Factors |
|---|---|
| The role of management leadership and quality policy (leadership) | Responsibility of the top executive for quality. Top management commitment to quality. Top management support for long term improvement. |
| Supplier quality management | Purchasing policy emphasizing quality rather than price. Reliance on supplier process control to reduce inspection of incoming material. Supplier quality control. |
| Process quality management | Worker centered quality control. Clarity of work or process instructions. Use of SPC/SQC in quality control program. Quality data as tools to manage quality. |
| Quality data and reporting (information and analysis) | Availability of quality data. Visibility of quality data. Conducting audits to obtain data. Total quality cost system. |
| Human resource development and management (employee relations) | Provisions of statistical training, quality related training for all employees. Open communication between workers and top management. Quality circles. Employee involvement. Participative management. |
| Customer focus and satisfaction | Customer focus in quality definition. Tracking of customer satisfaction. |
| Strategic quality planning | Product design review before production and marketing. Coordination between quality control and other departments. Specificity of quality goals. Constancy of purpose. Continuous improvement. |

researchers. Also, this set of criteria is sufficient for measuring the basic guidelines of the Malcolm Baldrige National Quality Award criteria and the extent of effective quality management practices in a business unit.

# CHAPTER III

# RESEARCH METHODOLOGY

This chapter presents the research hypothesis, research procedures, questionnaire design and the analysis of the data.

## Research Hypothesis

Literature suggests that the benefits of strategies like Just In Time and Total Quality Management are substantially greater than those of traditional manufacturing practices. More important, it suggests that two strategies have significantly improved product quality and productivity. The research propositions presented here are derived from this point.

The overall objectives of the empirical research are to determine:

1. Whether the performance of firms implementing both JIT and TQM is better than the performance of firms not implementing JIT and TQM.

2. Whether the performance of firms implementing only JIT is better than performance of firms implementing both JIT and TQM.

3. Whether the performance of firms implementing only TQM is better than performance of firms implementing both JIT and TQM.

4. Whether the performance of firms implementing intensive JIT-TQM is better than the performance of firms implementing less intensive JIT-TQM.

## Research Procedures

The research procedures employed in this study is a cross sectional field survey using the questionnaire data gathering method. A list of manufacturing firms in the West Michigan area was obtained from 1992 edition of the Michigan Industrial Directory.

The data was to be collected from 285 manufacturing companies representing various industries. Apart from the qualification that all firms had to have over 50 employees, all types of manufacturing were firms included. Sizes ranged from small to medium to large, products, manufacturing and the type of the operation also varied.

## Questionnaire Design

A copy of the cover letter, the remainder and questionnaire are contained in Appendix A. The questionnaire consists of 6 sections that address the areas of interest discussed in the previous chapter. It is intended to obtain data in the areas of: (1) Company description; (2) Supplier relations; (3) Internal manufacturing; (4) Quality management; (5) Performance factors such as (a) Operating indicators, (b) Customer focus, (c) Financial performance, (d) Employee relations, (e) Supplier performance; and (6) JIT-TQM implementation problems.

The questionnaire was felt to be comprehensive and understandable, the only concern being that the questionnaire took a long time to complete. It was decided not to reduce the scope of the questionnaire because it would not be possible during this research effort to send out separate questionnaires to address each area with individual questionnaires.

The questionnaires consisting of four pages and 81 questions were sent to 285 companies. They were directed at the quality assurance/control manager, manufacturing/production manager, plant/faculty manager and the director/vice president of quality according to their familiarity and involvement with the programs. Data was collected only from one manager in each company.

The number of surveys that could be sent out for this research was somewhat limited because of the expenses associated with conducting such a survey. Surveys were mailed in three batches using bulk mailing procedures. It was hoped that by prepaying the return postage the return rate would be increased because there were no funds to payoff additional phone follow-up although a reminder was sent approximately 30 days after the surveys were mailed.

## Analysis and Presentation of Data

The following sections present a review of the information obtained from returned surveys. From the list of 285 questionnaires which were sent out to companies, 76 were returned. Of these seventy six, sixty four could be used for the data analysis. The remaining twelve questionnaires were unusable due to incomplete

or delayed responses. Each section in the questionnaire will be considered separately, followed by general comments and observations about the survey.

Company Descriptions - Section 1

Table 4 lists the descriptions of the companies that returned the usable surveys. As the table shows the highest number of responses were from the Automotive parts and component manufacturers (twelve), and Primary metal industries (twelve). The Primary metal industries included metal stamping, fabrication, steel welding and processesing of iron and steel. Machinery manufacturers (nine) included makers of industrial valves, gas cylinders and sealants. Eight of the companies classified under Food and Kindered products (cookies, crackers, candies, bread, food processing) returned the completed questionnaires. Seven companies each under Furniture and Fixtures (wood and steel) and Paper and allied products (labels, boxes, containers) also participated in the study.

The highest level of authority responding were the directors/vice presidents of quality/manufacturing. Seven of the respondents were at this level in the Automotive parts industry, six in the Metal industry and four from the Furniture and Fixture industry. The lowest level of authority who responded in this survey were engineers in the quality and production areas. There were five respondents each, at this level from the automotive parts, food and kindered products and the metal industry. With respect to the size of the responding companies, they were classified as small, medium and large. This classification was based on the number of workers employed in the

Table 4

Information About Companies That Responded to the Survey

| Type of Industry | No. of Respondents | Level of Responding Authority | | | Size | | | Type of operation |
|---|---|---|---|---|---|---|---|---|
| | | D/VP | Pt/Fc | QE/PE | S | M | L | |
| Plastics | 3 | 3 | - | - | - | 2 | 1 | 1C |
| Medical Equip. | 2 | 2 | - | - | - | 1 | 1 | 2A |
| Automotive pts.(Plastics and Metal) | 12 | 7 | - | 5 | 3 | 4 | 5 | 2A,3C, 3D,$1^{C}_{D}$ |
| Food & Kindered Pdts. | 8 | 1 | 2 | 5 | - | 4 | 4 | 6C, 1D |
| Lumber and Wood Products | 1 | 1 | - | - | 1 | - | - | 1D |
| Furniture & Fixtures (Wood and Steel) | 7 | 4 | - | 3 | 2 | 1 | 4 | 6C |
| Paper & Allied Pdts. (Label, Boxes) | 7 | 1 | 5 | 1 | 5 | 1 | 1 | - |
| Printing and Publishing | 2 | 1 | 1 | - | 2 | - | - | 2C |

Table 4-Continued

| Type of Industry | No. of Respondents | Level of Responding Authority | | | Size | | | Type of operation |
|---|---|---|---|---|---|---|---|---|
| | | D/VP | Pt/Fc | QE/PE | S | M | L | |
| Chemical and Allied Products | 1 | - | 1 | - | 1 | - | - | 1C |
| Metal Industries | 12 | 6 | 1 | 5 | 7 | 3 | 2 | 8A,2C |
| Machinery | 9 | 3 | 3 | 3 | 4 | 4 | 1 | 2A,2C,2D $1^{A}_{C}$ |
| Total | 64 | 29 | 13 | 22 | 25 | 20 | 19 | 14A,23C, 7D,$1^{A}_{C}$, $1^{C}_{D}$ |

A = Low variety High volume

B = Low variety Low volume

C = High variety High volume

D = High variety Low volume

firms. Firms which employed between 50 to 250 workers were classified as small, 251 to 400 workers were classified as medium and firms with more than 400 employees were classified as large.

The firm with the largest number of employees responding had eight thousand workers. The lowest number of employees in the company that responded to this survey was sixty. Seven from the metal industry and five from the paper and allied products were in the small category. In the medium size category the highest number of respondents were from the automotive parts, food and kindered products and the machinery manufacturing industry (four each). Similarly the automotive parts industry had five respondents that were classified as large firms, while the food and kindered products and the furniture and fixture industry had four each in this category.

Also the companies surveyed were asked to describe the type of operations they were involved with. This was classified into four categories. Low variety High volume, Low variety Low volume, High variety High volume and High variety Low volume.

Eight companies from the metal industry described their operations as low volume high variety. Six companies each from the food and kindered products and the furniture and fixture industry described their operations as being at high volume high variety. Three companies from the automotive industry and two from the machinery manufacturing industry described their operations as high volume low variety.

One company from the machinery manufacturing industry described itself as having both low volume high variety and high volume high variety situations, while one company from the automotive parts industry described itself as having two types of operations, namely high volume high variety and high volume low variety. The one surprising factor was that none of the companies that returned the surveys were involved in a low volume low variety type of operation.

Internal Manufacturing Practices - Section 2

This section considered the respondents extent of use of manufacturing practices (Table 5). Possible responses to this section were provided on a likert scale that ranged from 1 representing the extent (or level of use) of very low to 5 representing very high. The average responses ranged from a high of 4.01 for continuous improvement programs to a low of 1.73 for poka-yoke practice of defect prevention. Given the importance of continuous improvement programs a high average of 4.01 suggests that companies are emphasizing heavily on this aspect. A low of 1.67 for poka-yoke suggests that this practice is either ignored or given very little emphasis. The fact that 17% of the companies surveyed commented this practice as not being applicable to their situation supports this contention.

Questions 27, 26, 31, 16, 14 and 21 which were regarding worker centered quality control/quality at the source, multi skilled workers/cross trained workers, employee involvement (suggestions and empowerment), reduction in work in process, preventive maintenance and reduced set up times had a score of 3.81, 3.8, 3.56, 3.36, 3.34, and 3.28 respectively. The question about practicing Quality at the source

Table 5

Responses to Particular Questionnaire Items With Respect to Manufacturing Practices

| Question | VH | H | M | L | VL | Average |
|---|---|---|---|---|---|---|
| Group Technology/Cellular Manufacturing | 6 | 14 | 15 | 14 | 13 | 2.68 |
| Preventive Maintenance | 11 | 16 | 24 | 9 | 5 | 3.34 |
| Kanbans/Pull Method of Material Flow | 4 | 10 | 11 | 16 | 21 | 2.28 |
| Reduction in WIP | 12 | 19 | 17 | 12 | 4 | 3.36 |
| Reduction in Lot sizes/ increase in number of setups | 1 | 26 | 16 | 14 | 5 | 2.97 |
| Reduced setup times | 8 | 24 | 16 | 12 | 2 | 3.28 |
| Continuous Improvement Programs | 20 | 26 | 15 | 3 | 1 | 4.10 |
| Cross trained workers | 14 | 25 | 22 | 3 | 1 | 3.8 |
| Worker centered quality control | 8 | 20 | 20 | 7 | 0 | 3.81 |
| Poka-yoke defect prevention* | 1 | 4 | 12 | 17 | 20 | 1.67 |
| Employee involvement (Suggestions and empowerment) | 9 | 24 | 23 | 8 | 2 | 3.56 |

* 11 Respondents answered not applicable

had no company rate it at the minimum score of 1. Twenty eight percent of the companies gave a very high score of 5, while 31% of the companies gave a score of 4 and 3 respectively. Regarding the practice of cross training workers, the bulk of the companies, 39% responded by giving a score of 4 while only 2% responded to this question with a score of 1.

Thirty percent gave a score of 4 and 27% a score of 3 for the question regarding the emphasis given to reduce the work-in-process.

When asked to respond to the question regarding preventive maintenance the maximum percentage of companies 38 gave a score of 3 and only 8% a low score of 1. Eighteen percent gave a high score of 5.

Questions about the use of Kanbans, Group Technology/Cellular Manufacturing, and reduction in lot sizes/Increase in the number of set ups elected average scores of 2.28, 2.68 and 2.97 respectively. Given that an average value of 3 would have represented a response of medium emphasis , it appears that respondents were giving a low emphasis to these concepts.

The scoring level reported regarding the questions that have low scores may not be completely indicative of a lack of knowledge of the techniques, methods and philosophies they espouse regarding JIT. It would, however, be highly unlikely that people familiar with the JIT manufacturing philosophy would be unfamiliar with these concepts.

Quality Management Practices - Section 3

This section asked the respondents about the extent of use of certain quality management practices (Table 6). The questions about quality consisted of the following categories - the role of top management (questions 34, 35, and 36), process quality management (questions 14, 27, 29, 41, 48, and 49), quality data and reporting (questions 39, 40, 42, and 43), human resource development and management/employee relations (questions 25, 28, 31, 33, and 46), strategic quality planning (questions 23, 37, 38, 44 and 45), and customer focus and satisfaction (questions 50 and 51). Possible responses to these questions were provided on a likert scale that ranged from 1 representing the extent of use as very low to 5 representing very high. Most of the questions in this section had a average score of 3 or more, indicating a more than medium emphasis on quality related practices.

Question 36, top management support for long term improvement had a high average of 4.23. Only 2% of the responding companies gave a very low score of 1 and 3% a low score of 2. 43% of the companies gave a very high score of 5.

Question 50, which asked companies about their focus on customers while defining quality, had 20% of the companies give a very high score of 5 while only 2% of the companies gave a very low score of 1. The average score for this question was 3.84. Questions 45, 38 and 47 had average scores of 3.59, 3.51 and 3.50. These questions were regarding the extent of coordination among departments during product development, specificity of quality goals and the coordination between quality control

Table 6

Responses to Particular Questionnaire Items With Respect to Quality Management Practices

| Question | VH | H | M | L | VL | Average |
|---|---|---|---|---|---|---|
| Top management support for long term improvement | 27 | 26 | 9 | 2 | 1 | 4.23 |
| Specificity of quality goals | 14 | 21 | 18 | 6 | 5 | 3.51 |
| Availability of quality data | 11 | 25 | 13 | 11 | 3 | 3.42 |
| Use of quality data as tools to manage quality. | 8 | 24 | 20 | 8 | 4 | 3.37 |
| Product design review before Production and marketing | 7 | 23 | 21 | 8 | 5 | 3.29 |
| Coordination among departments during product development | 6 | 30 | 20 | 8 | 4 | 3.59 |
| Training in total quality concept throughout the firm | 7 | 22 | 16 | 13 | 6 | 3.17 |
| Coordination between quality control and other departments | 6 | 24 | 28 | 6 | 2 | 3.5 |
| Use of SPC/SQC in quality control program | 8 | 19 | 17 | 11 | 9 | 3.09 |
| Clarity of work or process instructions | 7 | 21 | 27 | 7 | 2 | 3.37 |
| Customer focus and quality definition | 13 | 32 | 14 | 5 | 1 | 3.84 |

and other departments. Only 3% of the companies gave a very low score of 1 for question 47 while 47% gave a high score of 4 for question 45.

Supplier Management Practices - Section 4

The questions in this section consider the management practices of firms with their suppliers (Table 7). The six questions presented in this section address the various aspects of supplier management. Although the possible responses to these questions were provided on a likert scale that ranged from 1 representing the extent of use as very low and 5 representing very high, the scoring for questions 7 and 9 that were regarding the extent of selecting suppliers based on price and the extent of inspection of incoming material was reversed. Here a score of 1 represented very high, a score of 2 represented high, 3 represented medium, 4 represented low and 5 represented very low, due to the nature of these questions. However, the scoring for these questions were scaled as regular, meaning the interpretation of the scores are the same for the purpose of this analysis.

Review of the responses to questions in this section are as follows: Questions 6, 10 and 8 regarding the extent of use of the practice of basing supplier selection on qulatiy, the frequency of shipments and the lot size, and the capability analysis of suppliers had average scores of 3.89, 3.23 and 3.18 respectively. 22% of the companies gave a very high score of 5 to question 6, 54% of them gave a high score a high score of 4 and none of the companies rated it at the lowest score of 1. Question 8 had a high score of 4 by nearly 41% of the companies that responded. 6%

of the companies gave a low score of 1 for this question.

On the other end questions 7, 9, and 5 which were about the extent of use of practices such as selecting suppliers based on price, inspection of incoming material and the use of the certification for supplier selection had average scores of 2.53, 2.90 and 2.93 respectively. Forty one percent of the companies gave a medium score of 3 for question 7, while 31% gave a low score of 2. Only 3% of the companies gave it a very high score of 5. Thirty three percent of the companies gave a medium score

Table 7

Responses to Questionnaire Items With Respect to Supplier Quality Management Practices

| Question | VH | H | M | L | VL | Average |
|---|---|---|---|---|---|---|
| Supplier certification | 5 | 19 | 19 | 9 | 12 | 2.93 |
| Supplier selection based on quality | 14 | 35 | 9 | 6 | 0 | 3.89 |
| Supplier selection based on price | 10 | 20 | 26 | 6 | 2 | 2.53 |
| Capability analysis of suppliers | 2 | 26 | 22 | 10 | 4 | 3.18 |
| Inspection of incoming material | 8 | 17 | 21 | 9 | 9 | 2.9 |
| Frequent shipments in small lots | 11 | 11 | 28 | 10 | 4 | 3.23 |

of 3 for the question regarding the importance given to incoming material inspection. Eight percent of the companies gave a very high score of 5 for the certification of suppliers while 19% gave a very low score of 1. Again, given that an average score of 3 would have represented a response of medium emphasis, it appears respondents that respondents were giving less than medium emphasis to these practices.

JIT / TQM Implementation Problems - Section 5

This section analyses the organizational problems faced by companies during the implementation of JIT and or TQM practices. Question 52 had asked companies if they had implemented either JIT, TQM or both of these strategies. Companies which responded as being either JIT or TQM, were considered for this analysis. This accounts for the low sample size (51) as compared to other sections. Respondents were asked to rate to what extent (Very Much, Much, Some, None) they faced these problems. A review of the literature reveals that companies implementing these practices, encounter several organizational problems such as lack of top management support, lack of employee support / cultural resistance to change, lack of vendor support, lack of company expertise (education and training) in JIT/TQM, and lack of clear goals for JIT/TQM. The findings in this research were quite consistent with the expectations.

Table 8 gives an idea of how companies responded to questions from this section. From the list of problems identified, the most significant problem involved in the implementation of JIT/TQM was identified as lack of sufficient resources.

Only 14% of the companies said they had no problems with regard to the availability of resources. 43% said they had some problems, while 32% said this was a major problem. This could be an indicator of the problem of estimating potential JIT/TQM benefits in order to cost justify the implementation and companies trying to implement too many changes at one time.

Table 8

JIT/TQM Organizational Problems During Implementation

| Question | VM | M | S | N |
|---|---|---|---|---|
| Lack of top management support | 2 | 11 | 10 | 28 |
| Lack of employee support/ cultural resistance to change | 3 | 12 | 32 | 4 |
| Lack of vendor support | 1 | 9 | 27 | 14 |
| Lack of company expertise in JIT/TQM | 4 | 10 | 30 | 7 |
| Lack of sufficient resources | 6 | 16 | 22 | 7 |
| Lack of clear goals for JIT/TQM | 3 | 9 | 28 | 11 |

Questions 76 and 78, lack of employee support and lack of company expertise in JIT/TQM followed closely behind. The bulk of the companies in this category 63% and 59% indicated that these factors caused some problems. The reason for this

could be, that the magnitude of change necessary for JIT/TQM is not completely understood. Also employees would not have been appraised of the benefits obtained by these practices.

For the question, lack of clear goals, 55% said it did cause some problems, while 24% rated it as a major problem during implementation indicating lack of proper planning and organizing.

The question that had a high percentage of respondents in the no problem category was regarding top management support. Fifty five percent of the companies said that gaining top management support was not a problem while only 4% of the companies mentioned it as a major problem. This indicates a growing interest by the management in these concepts.

## Correlation Analysis

Table 9 shows the correlation among a subset of the performance variables. The correlation were as expected. There was a correlation between the quality of goods produced, percentage of scrap and rework, overall customer satisfaction of the companies products and services, quality of incoming parts and with the number of suppliers (questions 53, 54, 58, 72 and 73) shows the overall quality of the goods produced is related with the reduction of the scrap, rework, quality of incoming parts and reduction in the number of suppliers and that overall customer satisfaction is certainly tied with the quality of the product. There was also a correlation between production lead time and the percentage of orders filled on time (questions 55 and

61). Overall customer satisfaction had positive correlations with the return on sales, return on assets and quality of incoming parts. Also employer satisfaction and a high positive correlation with team work.

## Analysis of Variance Test

An ANOVA test was performed at alpha = 0.05 to determine whether there was a difference in the mean value of the evaluation between the eleven different

Table 9

Co-relation Analysis

| Variable | 54 | 58 | 61 | 64 | 65 | 71 | 72 | 73 |
|---|---|---|---|---|---|---|---|---|
| 53 | 0.37 | 0.55 | | | | | | 0.37 |
| 55 | | | 0.41 | | | | | |
| 58 | | | | 0.48 | 0.49 | | 0.43 | |
| 66 | | | | | | 0.47 | | |

variables. These were the same variables as the ones in the correlation table (Table 9). Table 10 shows the results of this test.

By this test there was a significant difference (observed $p$ = 0.0001) in the mean ratings of the percentage of the scrap and rework, and production lead time. Companies found that these variables decreased considerably while the rest of the variables decreased somewhat.

Hypothesis 1

Performance of firms implementing both JIT and TQM is better than the performance of firms implementing none. The results are shown in Tables 11 and 12.

For the section Customer focus (questions 58 to 61) there was a significant

Table 10

ANOVA Table

| Grouping | Mean | Critical Items |
|---|---|---|
| A | 3.92 | Quality of goods produced |
| A | 3.92 | Overall customer satisfaction |
| A | 3.92 | Percentage of orders filled on time |
| A | 3.87 | Quality of incoming parts |
| A | 3.69 | Return on assets |
| A | 3.67 | Team work |
| A | 3.63 | Return on sales |
| A | 3.52 | Number of suppliers |
| A | 3.36 | Employee satisfaction |
| B | 2.49 | Percentage of scrap and rework |
| B | 2.16 | Production lead time |

N=55

difference in the means with $p = 0.05$. Similarly for the section on employee relations (questions 66-71) there was a significance with $p = 0.04$.

Table 11

t-Test Results for Customer Focus

| Strategy | N | Mean | α Value |
|---|---|---|---|
| JIT & TQM | 12 | 15.08 | |
| NONE | 12 | 13.08 | 0.05 |

Table 12

t-Test Results for Employee Relations

| Strategy | N | Mean | α Value |
|---|---|---|---|
| JIT & TQM | 12 | 20.58 | |
| NONE | 11 | 18.72 | 0.04 |

Given the importance of customers in the implementation of both strategies, these are in-line, confirming that JIT-TQM companies emphasize strongly on customer focus than firms not implementing these strategies (Table 13).

There is also a difference in the relationship with employees, between the

firms implementing JIT and TQM and the firms not implementing JIT and TQM. This section included variables such as employee satisfaction, absenteeism rate, employee turnover, percentage of suggestions implemented, worker flexibility and team work.

There was no significant difference with respect to Financial performance. Maybe, this was due to the fact that this change is seen after a considerable period of time since the initial implementation of these strategies (most of the companies were between 0 to 24 months since implementation).

Hypothesis 2

Performance of firms implementing JIT is better than the performance of firms implementing both JIT and TQM.

This hypothesis is rejected meaning there is significant difference in the strategies. Probably the reason for this for this could be that there is some level of integration between these two strategies. For the overall performance of firms implementing JIT, quality is also an important factor. This study proves that a JIT firm should also concentrate on quality. In other words JIT firms cannot reap the full benefits of this strategy without emphasizing on quality as a key element of JIT.

Hypothesis 3

Performance of firms implementing TQM is better than the performance of firms implementing both JIT and TQM.

This hypothesis is rejected meaning the performance of firms implementing both JIT and TQM is better than firms implementing only TQM. The concept of JIT

Table 13

t-Test Results for Customer Focus

| Strategy | N | Mean | α Value |
|---|---|---|---|
| Intensive JIT & TQM | 6 | 17.16 | |
| Less intensive JIT & TQM | 31 | 15.41 | 0.03 |

helps in the implementation of TQM. When firms think of implementing TQM, the JIT strategy plays an important role.

From the hypothesis it can be said that firms implementing JIT/TQM have had better performance than firms not implementing both of these strategies simultaneously. Therefore firms implementing JIT and TQM by itself should integrate both these concepts, since their synergistic effect could boost quality and productivity, than when these concepts are implemented by themselves.

Hypothesis 4

Performance of firms implementing JIT-TQM more intensively is better than that of the firms implementing both the strategies less intensively.

For the t-tests, the companies that responded from the four categories, firms

implementing JIT, firms implementing TQM, and firms implementing both of these strategies were further sub-divided into companies that were implementing JIT intensively, TQM intensively and both JIT and TQM intensively.

This sub-division was done on the basis of their scoring points. Companies who averaged a score between 0 to 40 were grouped as companies not implementing any of these strategies, firms scoring between 40 to 75 were grouped as companies implementing JIT less intensively and TQM less intensively, while firms that averaged a score between 75 to 100 were grouped as companies JIT, TQM or both intensively. The total scores of the companies were compressed to a maximum of 100 points for this purpose. As Figure 4 shows, this method helped group the companies mainly at implementing both JIT and TQM intensively, and JIT and TQM less intensively.

The results of this test show that firms implementing intensive JIT-TQM have better supplier performance (Table 14) and their overall performance factors (Table 15) which include operating indicators, customer focus, financial performance and employee relations are better than those firms implementing less intensive JIT-TQM. These results are in line with the benefits of intensive JIT-TQM as portrayed in the present literature. This suggests that companies should therefore go for intensive implementation of these practices to realize the maximum benefits.

Table 14

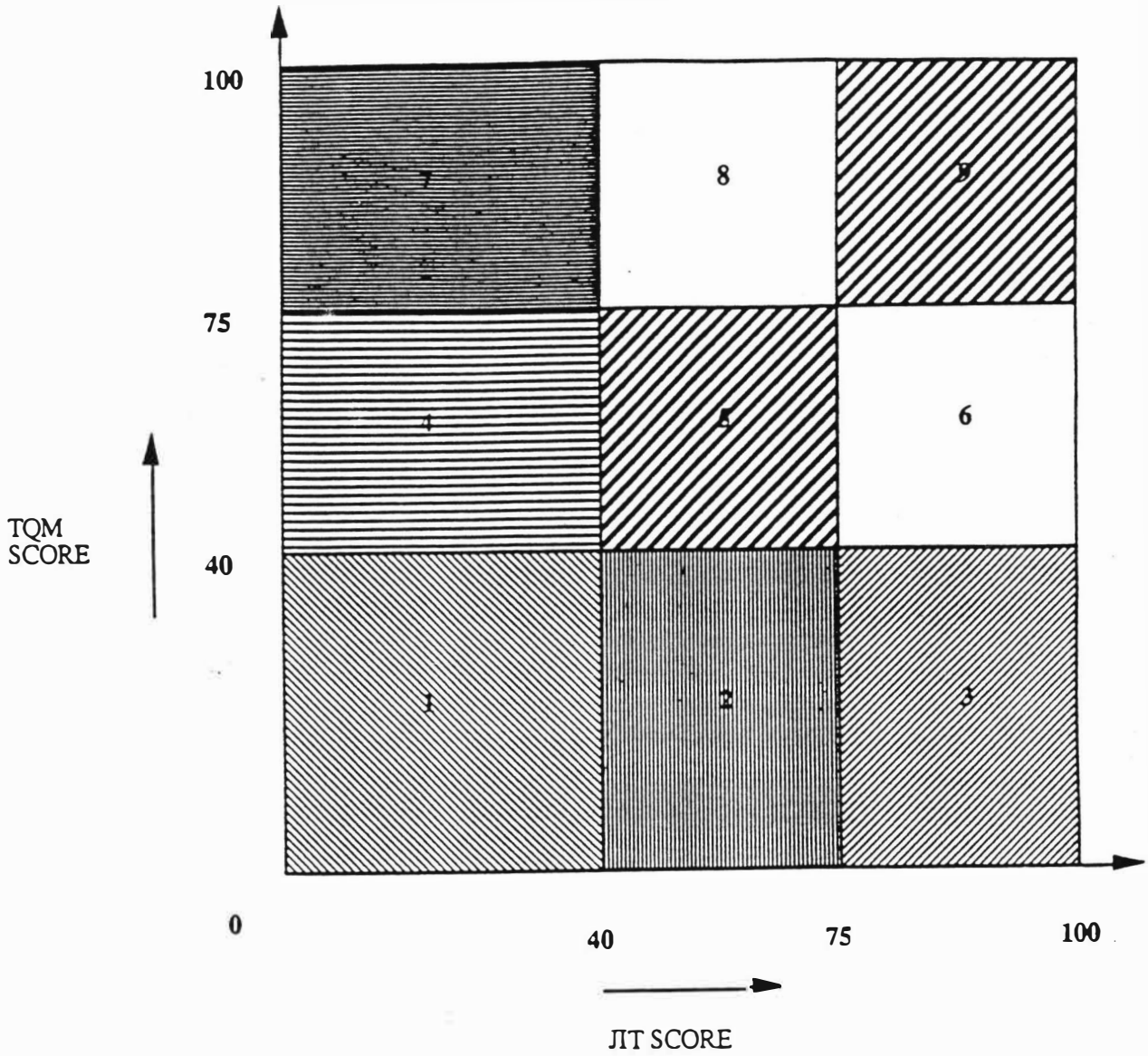
t-Test Results for Supplier Performance

| Strategy | N | Mean | α Value |
|---|---|---|---|
| Intensive JIT & TQM | 5 | 11.2 | |
| Less Intensive JIT & TQM | 31 | 10.06 | 0.10 |

Table 15

t-Test Results for Overall Performance

| Strategy | N | Mean | α Value |
|---|---|---|---|
| JIT-TQM | 12 | 14.46 | |
| JIT | 13 | 14.23 | 0.80 |
| JIT-TQM | 12 | 14.46 | |
| TQM | 15 | 14.53 | 0.91 |
| Intensive JIT & TQM | 5 | 85.60 | |
| Less Intensive JIT & TQM | 27 | 80.48 | 0.09 |




1 = Non JIT, Non TQM  2 = N-JIT $_L$  3 = JIT $_I$

4 = TQM $_L$  5 = JIT $_L$, TQM $_L$  6 = JIT I,TQM $_L$

7 = TQM $_I$  8 = JIT $_L$, TQM $_I$  9 = JIT $_I$, TQM $_I$

I = Intensive  L = Less Intensive

Figure 4. Classification of Companies Based on Total Scores.

# CHAPTER IV

## CONCLUSIONS AND RECOMMENDATIONS

Several major conclusions can be drawn in the area of quality and productivity management practices, particularly on JIT and TQM practices, from the results of this research and the literature reviewed.

The JIT-TQM system appears to be one of the most appealing techniques among various approaches to resolve the product quality and productivity problems.

The research described in the previous chapters examined the critical variables of JIT and TQM. The results of this study suggest that, first, it is important to analyze the critical variables that are conductive to successful implementation of JIT and TQM. Second, it is important to delineate the real benefits of JIT-TQM practices compared with traditional management practices. Third, it is possible to identify key organizational problems that manufacturing companies typically encounter in implementation of JIT-TQM.

This research examined four propositions concerning JIT and TQM. First the performance of firms implementing both JIT and TQM, second, the performance of firms implementing JIT, third, the performance of firms implementing TQM and fourth, the performance of firms implementing intensive JIT-TQM.

The results of the data analysis suggest that there are several important variables required for successful implementation of the JIT-TQM concept. They also

demonstrate that benefits of JIT-TQM are substantially greater than those of traditional management practices. Even broader benefits are achieved by companies upon intensive implementation of these practices.

The results of this research indicate that there are several major problems which companies encounter during the implementation of JIT-TQM.

Lastly, the results strongly support the ideas that the major activities of JIT-TQM can improve product quality and productivity.

## Limitations

The validity of the research suffers from the sampling limitations. The limitation is that the sample size for the questionnaire survey was small, especially the usable returned questionnaires.

The activities (variables) of JIT and TQM selected to develop the questionnaire could also be considered somewhat as a limitation of this study. In this study, major activities of JIT and TQM which could be important to some companies, depending on the nature of their business, and these activities could also affect their performances. Another important limiting factor was the time factor. Most of the companies that participated in this study were between 0 to 24 months since implementation.

Despite these limitations, the study has made contributions in the area of quality and productivity management practices such as JIT and TQM, including the following:

1. At the time of this research no empirical studies had examined the performance of intensive and less intensive JIT-TQM implementation. This study clearly reveals that the performance of firms intensively implementing JIT-TQM is better than firms implementing less intensive JIT-TQM.

2. Perhaps the most important contribution of this study is the fact that JIT and TQM are an integral part of product quality and productivity improvement practices. It is their synergistic effect that companies should be interested in, rather than trying to implement JIT or TQM by themselves. This study clearly shows that there can be no JIT without emphasis on Total Quality and likewise.
Manufacturing companies interested in implementing JIT-TQM can benefit from this research, and it should also help practicing managers in the implementation process.

## Recommendations

While this research has presented the extent the use of quality and productivity management practices such as JIT and TQM, further research is needed in several areas. It is important to develop a model through which the effectiveness of the relevant components/activities (variables) of JIT-TQM on product quality and productivity can be tested and assessed for organizations in different settings.

Additionally, different methods of sampling need to be employed for data collection. Furthermore companies need to be interviewed to help eliminate the potential for biased responses. Perhaps future studies could utilize archival data on quality and productivity levels in conjunction with responses to questionnaires and

interviews. Thus, a longitudinal study can become a reality.

These recommendations for future research may not be accomplished in the very near future, because implementation of JIT-TQM takes several years to be fully completed. As a result a large amount of data may not be available for some time. This study is intended to make a contribution to improving quality and productivity management practices in manufacturing firms. It is hoped that this study would challenge and encourage others to explore further in the future research areas described above.

Appendix A

Letter of Introduction for Questionnaire

Respected Sir/Madam,

Your cooperation is requested in gathering data for a Master's thesis on "Production and Quality Management Practices". The purpose of this study is to determine the level of the firm's involvement in quality and productivity improvement strategies and the firm's state of awareness/preparedness towards meeting the Malcolm Baldrige national Quality Award criteria.

Please respond to all items in the attached questionnaire. We tried to keep it short, yet complete. A stamped return envelope is enclosed for your convenience.

The data will be held in strict confidence. Only aggregated and summarized information will be reported. If you would like a copy of the final report of the study, please let us know. We will be pleased to provide a copy for your information.

Dr. Richard Munstermann, Chair, of the Industrial Engineering department, Dr. Tarun Gupta, Assistant Professor, Industrial Engineering, Dr. Damodhar Golhar, Chair, of the Management department and Dr. Sanjay Ahire, Assistant Professor of the Management department are advising and supporting me in this research.

Thank you very much for your help.

Sincerely,

Kiran Vuppalapati
Department of Industrial Engineering
Western Michigan University
Kalamazoo, MI 49008

Appendix B

Questionnaire for Survey of Production and Quality Management Practices

A SURVEY OF PRODUCTION AND QUALITY MANAGEMENT PRACTICES

1. Your job title.....
2. The number of employees in your firm.....
3. Nature of business of your firm
   a. Low volume High variety  b. Low volume Low variety
   c. High volume high variety  d. High volume low variety

4. Please indicate the extent of use of the following management practices in your firm using this scale: VH=very high. H=high. M=medium. L=low. VL=very low.

| SUPPLIER - RELATED | VH | H | M | L | VL |
|---|---|---|---|---|---|
| (5)a. Supplier certification | | | | | |
| (6)b. Supplier selection based on quality | | | | | |
| (7)c. Supplier selection based on price | | | | | |
| (8)d. Capability analysis of suppliers | | | | | |
| (9)e. Comprehensive inspection of incoming material | | | | | |
| (10)f. Frequent shipments in small lots | | | | | |
| **INTERNAL - MANUFACTURING RELATED** | | | | | |
| (11)a. Group Technology | | | | | |
| (12)b. Stable production schedule | | | | | |
| (13)c. Level/Uniform plant loading | | | | | |
| (14)d. Preventive maintenance | | | | | |
| (15)e. Kanbans/Pull method of material flow | | | | | |
| (16)f. Reduction in work-in-process | | | | | |
| (17)g. Efficient floor space utilization | | | | | |

VH H M L VL

(18)h. Under capacity scheduling

(19)i. Mixed model scheduling

(20)j. Reduction in lot sizes/Increase in number of setups

(21)k. Reduced set-up times

(22)l. Dedicated production lines

(23)m. Continuous improvement programs

(24)n. Parts/Component standardization

(25)o. Open communication between workers & top management

(26)p. Cross trained workers (shop floor)

(27)q. Worker centered quality control

(28)r. Quality circles

(29)s. Poka-yoke defect prevention

(30)t. Use of cross functional teams

(31)u. Employee involvement (suggestions & empowerment)

(32)v. Group incentive schemes

(33)w. Participative management

QUALITY - RELATED

(34)a. Responsibility of the top executive (profit & loss) for quality

(35)b. Top management commitment to quality

(36)c. Top management support for long term improvement

VH H M L VL

(37)d. Constancy of purpose

(38)e. Specificity of quality goals

(39)f. Total quality cost system

(40)g. Availability of quality data(error rates,defect rates etc.)

(41)h. Use of quality data as tools to manage quality

(42)i. Visibility of quality data, control charts,etc.

(43)j. Conducting quality audits to identify improvement areas

(44)k. Product design review before production & marketing

(45)l. Coordination among depts. during product development

(46)m. Training in total quality concept throughout the firm

(47)n. Coordination between Q.C. and other departments

(48)o. Use of SPC/SQC in quality control program

(49)p. Clarity of work or process instructions given to employees

(50)q. Customer focus in quality definition

(51)r. Tracking of customer satisfaction

(52) 5. Have you formally implemented any or both of the following programs :

YES NO IF YES, WHEN

I. JUST-IN-TIME

II. TOTAL QUALITY MANAGEMENT

6. If you have implemented either JIT or TQM or BOTH please indicate the level of change since implementation. Otherwise please indicate the level of change over the last five years:

Please use the following scale:

DC = decreased considerably
DS = decreased somewhat
S = same
IS = increased somewhat
IC = increased considerably

A. Operating indicators: DC DS S IS IC

(53) 1. Quality of goods produced

(54) 2. Percentage of scrap and rework

(55) 3. Production lead time

(56) 4. Inventory turnover

(57) 5. Production lot size

B. Customer focus:

(58) 1. Overall customer satisfaction of your products & services

(59) 2. Response time for customer requests

(60) 3. Order turnaround time

(61) 4. Percentage of orders filled on time

C. Financial performance:

(62) 1. Market share

(63) 2. Sales per employee

(64) 3. Return on sales

(65) 4. Return on assets

DC DS S IS IC

D. Employee relations:

(66) 1. Employee satisfaction

(67) 2. Absenteeism rate

(68) 3. Employee turnover

(69) 4. Percent of suggestions implemented

(70) 5. Worker flexibility

(71) 6. Team work

E. Supplier performance:

(72) 1. Quality of incoming parts

(73) 2. Number of suppliers

(74) 3. Percent of on time deliveries

7. The following section relates to JIT/TQM implementation. Please indicate to what extent you have encountered the flowing. Scale: VM=very much. M=much. S=some. N=none

VM M S N

(75)a. Lack of top management support

(76)b. Lack of employee support/cultural resistance to change

(77)c. Lack of vendor support

(78)d. Lack of company expertise (education & training) in JIT/TQM

(79)e. Lack of sufficient resources

(80)f. Lack of clear goals for JIT/TQM

Thank you for completing the questionnaire. Please give your name and address if you want a summary of the results.

Appendix C

Reminder

Respected Sir/Madam,

In the month of March 1993 we sent you a survey questionnaire titled "Quality and Productivity Management Practices". Please take a few minutes to complete and return the questionnaire. If you have already done so please ignore this reminder.

Your response will be used to determine your firm's level of involvement in quality and productivity improvement practices such as Total Quality Management and Just-in-time and your firm's awareness/preparedness towards meeting the basic guidelines of the Malcolm Baldrige National Quality Award criteria.

We reiterate that your responses will be held in strict confidence and only summarized results will be published.

If you need an extra copy of the questionnaire feel free to call either-
Dr. Tarun Gupta at (616) 387 3749 or Kiran Vuppalapati at (616) 387 7572.

Thank you for your help.

Sincerely,

Kiran Vuppalapati
Dept. of Industrial Engineering
Western Michigan University
Kalamazoo, MI 49008.

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