Title: Management Techniques to Achieve Competitive Advantage in High Technology Companies

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Engineering Management Synthesis
EMGT560

August 11, 1992

Prepared By

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Carrie Pak
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Submitted to

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Abstract/Executive Summary

In the burgeoning market for high-technology products, the US companies are becoming less competitiveness in spite of the great technical achievements. Many high-tech companies are finding that technology does not have to be developed in-house; many time it is acquired from other companies. This coupled with diminishing physical borders between companies, the technology in itself does not offer a competitive advantage anymore. It is the management of these technologies that will offer advantages.

The strengths and weaknesses of Total Quality Management (TQM), Self-Directed Teams (SDT), Proactive Management (PM), and the Management by Objective (MBO) management techniques were researched. A literature search was conducted to determine the issues of these techniques and to determine the most critical success factors (CSFs) that are deemed essential for the success of these management techniques. Personal Interviews were conducted with ten project managers in local high-tech companies. They were asked to compare the four management techniques against the CSFs. The pair-wise comparison method (PCM) was used for analysis.

The study found that the TQM is the best technique for the US high-tech companies to gain competitive advantage. The recommendations include the need for top management support and involvement with the implementation of TQM.

I. Introduction

A. The Need For The Study

In the worldwide market, US high-tech companies are being surpassed by their Japanese competitors. For example, GTE [1] was poised to become a major player in the information technology industry. In 1980, its sales were $9.98 billion and had a net cash flow of $1.73 billion. In contrast, NEC was a much smaller company with $3.8 billions in sales, with the same technological base. By 1988, GTE sales were $16.46 billion and that of NEC were [94] $21.8 billion. It is projected that Japanese industries will control 50% of the hardware content of the personal systems market by 1995 [2]. The severity of the situation was evident in a *Harvard Business Review* [2] article which reported that even though the US is the leader in technological innovations, "[US and European] companies will either fail outright or become, in effect, local design and marketing subsidiaries of Japanese companies". The problem is compounded by the erosion of physical borders [3] between countries. In the "borderless" world of today, companies are finding it easier to acquire new technologies by forming myriad strategic alliances and buying the technology that they need. This allows for easier exchange of technologies among companies. Such alliances help both organizations achieve their corporate objectives. Therefore, in the global market, technological excellence is no longer the key to success. The key to success is to manage technologies [4]. The engineering manager will play an increasing role in the success of companies in this high-tech borderless world of today.

The US companies have been trying to implement unorthodox form of management techniques in effort to address these challenges. Some techniques are company-wide and others are more departmental. Whatever the extent of implementation, these techniques have enormous impact on a company's survivor. For the purpose of this report, the following strategic management techniques have been selected for study:

- Total Quality Management (TQM)
- Self-Directed Teams (SDT)
- Proactive Management (PM)
- Management by Objectives (MBO)

B. Significance of This Study and Contribution to Engineering Management

This report will examine the current literature to study the four management techniques. A survey of high-tech industries will be conducted and the respondents will be asked to compare the four management techniques against the CSFs. The focus is on high-tech industries, and we have chosen to examine the most popular management techniques that are extensively implemented and supported by literature. The significance of this study is that it will allow engineering managers to make informed decisions in this continuously changing competitive environment. They will be able to implement the appropriate management techniques with the goal of building world leadership in the design and development of high-technology products. Even the most effective theories should be reviewed periodically for their effectiveness in the "real world". This research attempts to conduct this reality-check on a small scale. It is important to note that this is not a research study that includes the entire

spectrum of these industries. The research limited by time constraints and on available data in the local area. The research objectives are further discussed in the following subsection.

C. Problem Statement and Research Objectives

In the past 20 years, US companies have seen their market shares slide as foreign competitors have provided customers with higher quality products at reduced or equivalent prices [5]. This has caused US companies to change the structure and culture of their present organizations. "The successful firm of the 1990's will be: flatter, populated by autonomous units, oriented towards product differentiation, quality-conscious, service-conscious, more responsive, much faster at innovation, and a user of highly flexible people [6]." The management techniques being studied in this research were selected because they attempt to address these characteristics.

In our opinion, the problem with the US high-tech industries stem from the traditional management philosophy that:

- Focuses on short term profitability rather strategic planning
- Targets quality improvement from the product point of view rather than addressing the customers' wants and needs
- Focuses on the domestic market rather than the global market

Our research objective are to:

1. Survey the management techniques in high-tech industries to determines what technique gives the best strategic advantage
2. Determine the relevance of some critical success factors (these factors are described in the Methodology Section) that impact the implementation of the above-mentioned management techniques
3. Determine the weaknesses of the four management techniques (This review will be accomplished through literature research.)
4. Make recommendations

D. Organization of the report

In Section II, results of the literature search that focus on organization and its impact on management, human aspects, and the management techniques are presented. The management techniques subsection is divided into four sections that address each technique as mentioned earlier. Research objective number 3 is discussed here.

Section III addresses the research methodology. This section includes discussion on the critical success factors (CSF) and the method used in the selection of these factors.

Section IV of the report includes the results from personal interviews/survey. The weights of the CSF, as determined by the interviews, are presented. The subjective values for each technique are compared with each CSF. Research objectives number 1 and 2 are discussed.

Finally, the conclusion and recommendations are made in the Section V. The strengths and weaknesses of the research are presented in this section. This section satisfies our research objective 4.

II. Literature research

A. Impact of Organizations on Management

The structure of an organization is influenced by the environment under which it operates. This environment is formed by both internal and external issues such as socio-political climate. US organizations focus on short-term profits to the detriment of long-term strategic planning. It is this long-term planning that is the hallmark of their Japanese counterparts. Japan's financial system has bypassed much of the short-term income pressures in favor of focusing on market share, growth, and total sales [7].

Governments can play an important role in how technology gets shared among public and private organizations. The atmosphere that the Japanese government has set up is conducive to growth and long-term planning. The Japanese government's role in shaping a long-term, proactive environment is provided by the Ministry of International Trade and Industry (MITI), whose primary goal is to develop a coherent industrial policy that focuses on international trade [7].

There is no equivalent to MITI in the US. In the US, there are severe anti-trust law requirements that prevent companies from sharing technologies and jointly performing

research and development (R&D). The result is that companies cannot pool their resources. Thus, there is no incentive for companies to increase communication, share knowledge, and thereby become industry leaders.

Rapid technological change has created a dynamic business environment in which management must anticipate rather than react. More emphasis must be placed on strategic management. The US has traditionally been reactive in its path towards pooling resources and forming consortiums. For example, Sematech, a consortium of semiconductor industries that included Intel, IBM, and Motorolla was formed only after it was felt that there was a need to protect US interests.

US companies are continually making technological breakthroughs. However, they have been unsuccessful at turning these technologies into marketable products. This is caused by the functional separation of R&D and manufacturing. US corporations are missing opportunities to upgrade their products because they neglect to make modest but continuous improvements on their products.

For the high-tech industries, the strategic focus should be on forward thinking, implementation, monitoring, control, and re-adjustment. The strategic perspective of the organization must emphasize a total systems view of the organization, interaction with the environment, and anticipatory control [8]. Communication between functions in an organization (for example R&D and manufacturing) is critical.

B. Human Aspects in Management

1. Managerial Behavior

There are many theories of human behavior [9]. The purpose of this section is not to review all aspects of this field, but rather to examine how they may influence implementation of different management techniques. Understanding human behavior, particularly managerial behavior, when implementing a particular management technique is essential to success.

Over the years, the models that examine people and organizations have become more dynamic and complex [10]. These models have gradually shifted from an emphasis on physical and structural factors, to human relationship and interactions, which incorporate quantitative methods and computer technology in organizational decision-making. Management theorists' current thinking is towards a more integrated approach in the systematic analysis of organizations, their members, and their environments [10]. These models have moved from "one-best-way" approaches to a situational or contingency perspective. In this mode, there seems to be convergence of various schools of thought. The field of managerial behavior science is moving towards the point where true participation might best be conceived as getting people involved in solving not just their own, individual problems, but those that are considered as system-wide in nature [11]. For all of the management techniques discussed in this report, this concept of organization as a system is directly pertinent.

2. Conflict Identification and Classification

One of the key challenges of a leader is to recognize and correct conflicts that exist among employees. By fully understanding the organization, a leader is able to intervene when necessary to circumvent conflicting situations. Conflicts can be dealt with in five conflict-handling modes [10]:

- Avoiding: an unassertive, uncooperative approach in which both groups neglect the concerns involved by sidestepping the issue or postponing the conflict by choosing not to deal with it.
- Competing: an assertive, uncooperative mode in which the groups attempt to achieve their own goals at the expense of the other through argument, authority, threat or even physical force.
- Accommodating: an unassertive, cooperative position where one group attempts to satisfy the concerns of the other by neglecting its own concerns or goals.
- Compromising: an intermediate approach in which partial satisfaction is sought for both through a "middle-ground" position that reflects mutual sacrifice. This stance is thus intermediate between assertiveness and cooperativeness because each group makes some concessions but also receives some concessions from the other.
- Collaborating: an assertive, cooperative mode that attempts to satisfy the concerns of both groups. Such mutual satisfaction involves an agreement to

conform the conflict, identification of the concerns of the different groups, and problem solving to find alternatives that would satisfy both groups.

Each of these modes is used at one time or another. The appropriateness of the style depends on the nature of the situation. The leader that can identify the appropriate mode will succeed in winning the group's respect.

3. Leadership

Some argue that to be a successful leader in an organization, the "leaders take their goals from the requirements of the organization and the needs of employees" [12]. According to Steve Jobs, the founder of Apple Computer, "Leaders are keepers of the dream". They work to have employees passionate about their vision, feel united and purposeful, be empowered to get things done, explore alternatives, and reflect and keep on learning [13].

The team organization model says that leaders persist tirelessly to develop strong relationships with employees, and relationships among employees [12]. They are committed to work with their employees to develop a team, united behind an engaging vision with a deep sense of confidence and the ability to explore and reflect [12]. Aspects of this model are prevalent throughout the management techniques reviewed in this paper. It is not an easy, quick fix to effective management or a blueprint for action, but it provides an integrated framework to understand leadership.

C. Management Techniques

1. Total Quality Management (TQM)

Total Quality Management (TQM) is defined as the totally integrated effort for gaining competitive advantage by continuously improving every facet of organizational culture [14]. TQM differs from traditional management in the following ways:

- Customer focus vs. management focus
- Quality first vs. profit first
- Multiple quality dimensions vs. single quality dimensions
- Management and worker involvement vs. no worker involvement
- Process orientation vs. results orientation

Each of these element is described in detail.

Customer Focus - The message behind this definition is that any concept of quality must be customer focused [14]. The purpose of any business is to satisfy the customer. If the customers are not satisfied, at the very best they will do business with your competitor. At the very worst, they will not only take their business elsewhere but also their friends'. Without customers, you have no reason to be in business. So, the first element of organizational culture affected by TQM is customer focus. There is no question that a firm customer focus brings competitive advantage. Always remember, "The customer is always right" no matter how wrong he is!

Quality First - This element is hand-in-hand with the first element. The quality first says that quality is the company's foremost commodity and achieving it is of the utmost importance to the company. Once quality is achieved, attention can be directed to such thing as lowering unit costs. After all, what good is to produce a lot of garbage products at low price if no one buys them. Traditional management views profit as its first responsibility. The bottom line is increased for a short-term at the risk of quality. But, this orientation puts the cart before the horse. Profit will not increase if customers choose a competitor's product the next time around.

Multiple Quality dimensions - Quality has multi-faceted dimensions. According to Garvin [5], there are eight customer oriented quality dimensions:

- Performance
- Features
- Reliability
- Conformance to specifications
- Durability
- Serviceability
- Aesthetics
- Perceived quality

In traditional management, quality control/quality assurance programs cannot affect product quality because they have no relationship to customer preferences. It should be remembered that "doing the wrong thing right the first time" will do you no good. In other words, even a perfectly manufactured product will not have a market if customers prefer some other product. The can be avoided if the QC/QA program is tied to customer perceptions. In that case, the situation can be "doing the right thing right the first time".

Management and Worker Involvement - One way to measure effectiveness of any management techniques is to review its ability to channel all available resources to a common effort. In order to do this, the organization must have goals and objectives that are accepted and understood by the employees. The traditional management group would "tell" the employees what these are. TQM draws upon the concepts of participative management to empower the employees. The employees are given a significant role in determining the goals and objectives. Thereby becoming an owner of the mission.

The real power behind TQM comes from the top management's total commitment to achieving ever higher levels of quality from the customer's point of view. With management working in tandem with employees, departmental barriers are broken down and management is transformed. Rather than merely directing, management facilitates employee efforts.

It is important to keep in mind that this is a program which requires the top management's support. When support at the top is weak, the rest of the organization could suffer from

TQM apathy. This is especially true for the middle managers and first-line supervisors [16]. But if used properly, TQM can provide opportunities for those managers who can reinterpret corporate roles and develop new corporate cultures in their companies. Some industry experts contend that managers will succeed if they can reduce cycle times, reduce product defects or improve customer satisfaction [17].

Process Orientation - The process-oriented view, is a long-term, incremental approach to improving process quality. Since TQM empowers people to improve the way they work, people are the source of all improvement efforts. Barriers to communication are removed. The ability to continuously improve process is increased and encouraged.

The traditional management takes a different view. While recognizing the need to improve process quality, it preaches the big bang approach, where achievement is measured in terms of large changes in results. And the shorter the time, the greater the results. The result-oriented manager is forced into the position of always trying to leapfrog the competition by replacing current processes. By placing the emphasis on larger projects for the sake of ever greater results, the traditional manager increases the chances for failure.

There have been numerous articles and studies on why TQM is needed to bring about the market dominance that US companies once enjoyed. Perhaps Will Rogers stated best when he said, "Everyone says something must be done -- but this time it looks like it might be us." It's time for US companies to do something if they are to survive the global competition. US

companies must respond to foreign competition by adopting new attitudes towards product quality [18]. TQM can be implemented to improve companies':

- Competitiveness and market share
- Leadership abilities
- Quality and lower production cost

Simply stated, TQM's goal is to increase competitiveness and profitability through the management of people.

Instead of the traditional view that quality is necessary, managers need to implement total quality policies. US companies must abandon short-term outlook tendencies and commit to being involved in every level of the global marketplace. Total quality comprises identifying what quality is, adopting that concept for the whole company and developing a work environment that supports that concept of quality.

Theory and implementation are sometimes two completely different issues. When implementation of TQM, however, the organization must study and understand the theory if it is to succeed. There are some things an organization can do without significant management involvement, but TQM is not one of them. Few things will kill an organization's commitment to TQM more quickly than a perceived lack of management support [15]. Implementing TQM is not a matter of simply pointing the organization in the right direction

and turning it loose. The responsibility for implementing TQM cannot be delegated to others. It needs and demands leadership.

TQM makes the improvement process a part of the company's everyday operating system. Management's job is that of a leader, motivator, teacher, and nurturer [5]. This requires training that provides skills, knowledge, and abilities to employees. It is important before embarking on TQM that a company plans out transition to make it easier and more likely to succeed.

Leadership involves defining the need for change, creating new visions, and using new frameworks to mobilize commitment to those visions - frameworks for thinking about strategy, structure, and people. The framework should be a clear picture of leadership's goals for the organization, and should present key characteristics of the to-be style of business operations. The defined framework should answer the following questions [19]:

- What is the mission of the team?
- What are the principle products and services that we provide?
- Who are the principle customers?
- What are the users' needs?
- What indicators are we tracking to see how well we are doing?
- How are the users' needs met?
- How do we benefit the ultimate customer?
- How well are we doing?

- What can we do to improve?
- What can I do to support the effort?

A point that continues to be dominant in all the literature reviewed is that TQM must be management led and company wide. It must involve everyone and focus on prevention, not detection. The final goal must be continuous improvement, not short-term project.

2. Self-Directed Teams (SDT)

According to Holpp [20], "SDT is relatively small group of people, functionally focused organizational units that are carefully structured to manage their own affairs." SDT activities include routine and critical operational activities as well as managerial activities vendor quality, safety and strategic long or short term planning [20][21].

For the SDT to work, leadership role must be clearly defined [21]. The training of leaders and team members, work redesign, system development, performance based compensation pay plans and organizational structure are essential aspect of successful SDT. Leaders, whether hired from inside or outside, should coach and act as initiator, facilitator, negotiator, and motivator for performance. In this sense, the leader should teach team members how to manage themselves. Letize and Donovan [22] stated that trends toward team structures and employee self-management have tremendous implications for the role of the supervisor. The most important step in the transition to SDTs is working with supervisors to help them identify the new roles and contributions that they will be called on to make. Supervisors are

called on for many different contributions and perform 4 critical functions:

- Team building
- People development
- Performance management
- Boundary management

Such skills as communicating, listening, and providing feedback are critical in a high-involvement setting. Supervisors are the crucial link in the development of teams and the empowerment of employees. However, they may be reluctant to let go if they see empowering others as a threat to their own security.

The leaders have a tremendous influence over the quality of teams' performance [23]. They can lead teams to perform better and achieve more by using self-directed team-building principles. However, it is extremely important that all team members are aware of the goals of self-directed team-building so they can help in the effort.

Equally important is that continuous training be given to both team leader and team members. The training should center on interaction, conflict resolution, and problem solving skills. The main purpose of training is to develop a mind-set for team organization. Teams can be used as a vehicle for continuous improvement that is necessary to remain competitive [12].

Holpp states the reasons to implement SDT are [24]:

- People take more responsibility for their own careers
- Team members are responsible for almost every operational and managerial areas including supervision, quality assurance, information systems, and human resource management
- Less supervision and high promises reduce need for middle managers
- Saves time and money
- Encourages increasing employee participation
- Compatible with other systems such as TQM

To ensure that a SDT works, a manager should share his authority and responsibility with team members by allowing them to make decisions about work and processes [24]. Holpp [20] claims that SDT can work with in a harmony with TQM.

For a successful implementation of SDT, Holpp [36] recommends the following stages:

- Define the problem
- Develop a mission statement
- Start company-wide training
- Develop a feedback system
- Develop an implementation plan
- Implement with a prototype team
- Train sales people first
- Celebrate success

- Depending on performance, expand the system
- Believe in the SDT process

Referring to a 1990 survey done by *Industry Week*, some of the reasons for unsuccessful SDTs are [20]:

- Insufficient training
- Supervisor resistance
- Incompatible systems
- Lack of planning
- Lack of management support
- Lack of union support

3. Proactive Management

Proactive management establishes an action plan to anticipate long and short term challenges. The action plan includes goals and objectives that will help the organization achieve its mission. The proactive organizations are on top of every challenge, are able to foresee problems coming, are innovative, and are constantly improving the relationships with other functional areas [25]. They appear to be decisive, firm and communicative. They tend to self-initiate contacts both inside and outside of their organization/work group in order to meet the goals of organizational and individual [9]. The goals of the individual must align with the goals of the organizations for the actions to be effective.

The traditional management style have required companies to focus heavily on the bottom line. As stated in the TQM section, this translates to short term profitability. What is good in the short term, does not necessarily contribute to the company's longevity. In fact, much of the short term remedies reduce the company's chances for survival. The proactive management forces the organization to plan in long term while being able to react to the short term fluctuation of a changing environment [26].

Proactive management is based on the philosophy of preventing problems rather than fixing them later. It reduces product development life cycle and cost by designing the products right the first time [27].

Leadership, career building, training of employees and leaders, communication among functions became important issues to ensure behavioral and cultural change in the company and individuals [28]. To implement proactive management successfully:

- All functional units must be proactive at the same time
- Leaders and engineers must be trained continuously
- All functions have to communicate well
- Corporate mission must "trickle down" to impact actions
- Maintain presence of Mission, Objective, Goals, Strategies, and Action (MOGSA) in every workers mind
- Increase empathy of every worker to each other

- Organizational structure must be "matrixed in workers minds"
- Exemplary leaders must be supported
- Individuals must commit to occupational excellence for both themselves and the organization

As an example of proactive management, we offer the Integrated Technology Management Framework, drawn from R.F. Monger [29]:

- Accept management's role in technological innovation
- Commit equal energies to each and every phase of technology management
- Create a vision for the technology infrastructure based on the general competitive capacity required for long term competition
- Build the technology infrastructure to produce quality products and services. Build quality into the infrastructure. Continuously improve quality.
- Manage technology as an investment, not a cost.
- Use appropriate standards to measure technologies benefits, not just accepted standards.
- Work to change the social, educational, political, and economic forces that shape managerial decision making with respect to information technologies.
- Technology follows the organization, the organization follows the mission.
- Establish appropriate mechanisms inside and outside the organization to assess new and emerging technologies and to transfer the resulting knowledge into the organization as a whole.

- Use technology as a positive force in the transformation of work. Prepare the work force for change.

4. Management by Objectives

Management by Objectives (MBO) is a process through which individuals in organization work together to identify common goals and objectives and coordinate their efforts to obtain them. In an MBO process, a supervisor and subordinate attempt to reach consensus on [30]:

- Goals the subordinate will attempt to accomplish during a specified period of time
- The means the subordinate will use to reach those goals
- How progress toward the goals will be measured and evaluated

Goals are set by the management in a collaborative way: supervisors and subordinates collaborate on the goal-setting process. Goals are communicated to the subordinates and the subordinates do the same for their direct reports and so on. Goals should be measurable. This is important because it is easy to say "I can do my best" but very difficult to measure. Goals should, therefore, be something like reducing cost, increasing market share and so on. After the goals are set, they must be monitored periodically. During this process, they can also be changed if appropriate.

MBO has a very strong potential because it provides unambiguous goals, clarifies basis for reward, and spurs communication. Performance appraisals can be made more easily and the system can be used for control purposes.

Research [31] indicate that there should be focus on goal commitment. The person's commitment is crucial to the performance. Using the expectation theory, the researcher have developed a model that identifies the factors that influence goal commitment.

Goal commitment is attractive when people make their commitments public, explicit, voluntary, and if they have a high need for achievement. Type A people (aggressive and competitive), are involved in their jobs and feel that the organization backs their goals and attainment. The chances to attain goals are increased if they perceive that organization back their causes, they see that others are also committed, and that their bosses support their goals. This phenomenon will also increase the person's self-esteem which helps create a stronger employee.

There are some weaknesses to this approach, however:

- Top management does not support or take part. Those who do not participate become cynical and think of their participation as a waste of their time and effort
- There is a tendency to over-quantify the goals for the purpose of verification. This results in a lot of wasted time
- A lot of paper work is involved because of the need for tracking

- Managers assign goals without inputs from managers
- There is a lot of emphasis on outcome. This encourages illegal acts
- Performance goals are different for different employees. This makes it difficult to make a uniform comparison

III. Methodology

A. Hypothesis

Our research is based on the following hypotheses:

H1. To stay alive in the high-tech business of today, TQM is the most effective strategic management technique.

H2. People who implement strategic management technique are formally trained.

H3. Cost is an important factor in implementing a strategic management technique.

B. Research Model

The Critical Success Factor (CSF) analysis is used as the research model. From an extensive review of current literature, the critical success factors that are common for all the management techniques were identified. These factors are deemed critical in the success of the implementation of the management techniques. The following subsection reviews the CSFs in detail.

C. Critical Success Factor Analysis

There are numerous methods proposed in the literature for the determination and identification of CSF [32]. Most involve ad-hoc judgements of experts and management. While such judgements might seem plausible, their validity is always questionable because of their subjective nature. More obvious means for success can be obtained by exploring the current literature for sources of the CSFs that give the users a competitive advantage and result in superior performance. Such sources should ideally have a feedback process. This feedback process should be easy to determine whether the selected CSFs are indeed distinct advantages. If so, the companies that adapt them should be clear winners and the ones that don't are clear losers. The CSFs should therefore be able to distinguish winning companies.

The literature search for the CSFs was focused on finding those factors that would allow us to determine companies with distinct advantages. Knorr [33] states that in the strategic environment of the 1990s, globalization will force multinational and domestic corporations to rethink their management processes. The competitive advantages of world-class organizations come from strict attention to seven dimensions of advantage:

- Competitive position
- Information technology
- Performance management
- Organization structure
- Cost of quality and service

- Organizational skills
- Organization culture

By reviewing the competitors, managers can determine who is winning or losing market share. While many companies have automated their tasks, they have failed to automate the gathering of critical information that might reduce lead time to market. Companies must measure the critical success factors and cost-performance drivers to be effective. An integrated process and the seven dimensions can help management understand the linkages and interaction of all resources within an organization.

Towards this end, the CSFs should satisfy the following constraints:

- They are the reasons for the performance difference among management techniques
- They are mutually exclusive
- Must be such that they can control the desired outcomes

Using these constraints, the following six CSFs were selected with the supporting literature.

1. Cost

In the literature research, [33][34][35][36][37][38], cost is clearly an important factor for manufacturing competence. Cost includes both traditional and nontraditional components. Traditional cost components are made of direct labor, material, and overhead. The indirect

labor installation costs are also considered to be traditional costs. Nontraditional cost components include prevention, appraisal internal and external failure costs. The selected management techniques are effective at reducing the nontraditional costs by using programs like the quality by design, zero defect, and minimum inventory. In the comparison of management techniques, installation cost was used.

2. Training

Hill and Freedman [39] state that to improve the work process, employees must be trained and educated to act appropriately in the interests of the company. Training should be tailored to the three segments of the employee population responsible for leading, managing and participating in the improvement activities.

Skills development, statistics, maintenance, and techniques to deal with vendors are important areas of training. The purpose of training is to improve skills in these areas and reduce any existing barriers to achieving excellence.

Communicative skills development is equally important. This skill allows the manager and employees to be effective both as senders and receivers of message. With effective communications skills, the members can learn, teach, and understand each other [29][40][41][42][43].

3. Communicative Organizational Structures

The key to organizational communication is to focus on the arrangement and structures of how information is channeled to the specific individuals and groups who need it. The way a group or organization is structured will ultimately determine the accessibility and ease of information exchange. The flat horizontal organizational structures tend to allow easier communication whereas the tall, vertical structures tend to promote a long chain of command [34][40][36][42][33][44].

4. Participation

Participative management has increasingly been used and recommended as an approach for improving satisfaction and productivity [45]. Major advantages of employee participation include the following [45][41][42][46][44]:

- Greater understanding and acceptance of decisions by subordinates
- Greater commitment to implement decisions
- Greater understanding of objectives
- Greater fulfillment of psychological needs, and therefore, greater satisfaction
- Greater social pressure on all members to comply with decisions
- Greater team identity, cooperation, and coordination
- Better means of constructive conflict resolution
- Better decisions

With these potential benefits, it is easy to see why it is a CSF.

5. Continuous Improvement

Great gains can be achieved by small increment of continuous improvements. Therefore, improvement is not a one-time effort. It must also be recognized that continuous improvement process must be incorporated into the whole company. It cannot be limited to the quality control and quality assurance department. All employees must continually examine every task, procedure, policy, product, and service in a highly structured manner to see if higher levers of quality can be attained from the perspective of the customers [41][42][47].

6. Motivation

Motivation of employees were found crucial for employee satisfaction [41][42][44][48]. With motivation, leader encourages, develops and promotes employees. To motivate employees sufficiently, an appropriate motivational model should be chosen depending on job characteristics, employee and managers' personalities. Every employee has different levels of needs and expectations from the leader. Therefore, the leader should implement appropriate style consistent with the job characteristics and employees' personalities to direct employee through organizational goals. To implement a certain leadership style with chosen motivational model, a leader should have a vision to motivate employees [49].

Bonito [42] states that when implementing an improvement effort, top management needs to

consider several crucial factors. All of these issues have a significant impact on the level of employee motivation and commitment and on the success of the improvement effort itself. There are 3 ways to begin to instill employee motivation and commitment early in the change effort:

- Make top management's commitment visible immediately and continuously to the rest of the organization
- Analyze the status of current improvement efforts
- Create a vision of the future for the entire organization and make sure it is communicated across the organization

D. Respondents

Data collection procedure was through a formal interview with Engineering Managers in local high-tech companies. The interviewees were all managers who were responsible for engineering groups, though sometimes their titles were not Engineering Managers. A total of ten managers from four local high-tech companies were interviewed. The names of the respondents and their representing companies are kept confidential.

E. Procedure

The primary instrument for analysis is the pair-wise comparison method (PCM) program [50]. A questionnaire was prepared for the interview. Appendix A contains a copy of the questionnaire.

The questionnaire asked the respondents to compare each of the six CSFs for all four management techniques (in pairs), resulting in six pair-wise comparisons for each of the CSFs for a total of thirty-six comparisons. In order to simplify the process, while maintaining consistency in comparisons, the respondents were asked to make each comparison on a scale of 1 to 4. The distribution of 100 points to each of the two alternatives had the following scale:

Scale	Distribution of 100 point for alternative A:B
1	50 : 50
2	67 : 33
3	75 : 25
4	80 : 20

Therefore, if there was no preference between management techniques A and B, points were equally distributed between A and B. For the other values on the scale, the respondents indicated their increase preference of A over B by selecting 2 through 4. The above choices assume that alternative A is always preferred over B. This was done for simplicity. If the respondents preferred B to A, then the respondents would indicated such a preference with a minus sign in front of the chosen scale. This was took into account when the PCM analysis was performed. The results of the analysis are presented in the following Section.

IV. Results

A. Introduction

The results of the interviews are presented in this section. Subsection B presents the demography of the respondents, including the outcome of formal training issue for the respondents. In subsection C, the final weights from the PCM analysis are given. These weights were then used for the CSFs to determine a score for the four management techniques. Subsection D presents further information on the CSF.

B. Respondent Formal Training Issues

A total of 10 managers were interviewed. 80 percent of the managers had some kind of formal training in the said management techniques. The training included both seminars or formal college level instruction. 100% of the respondents said that they were familiar with these techniques. In addition, at least one of the managers had over 18-years of direct experience with the techniques. As according to hypothesis number 2, people who implement strategic management techniques had formal training in the area.

C. Final Weights for the CSF

The responses were normalized and the results are in the Table 1:

Table 1
Relative Weights for the CSFs

Critical Success Factors	Weights
Cost	11
Training	17
Communicative organizational structure	19
Employee participation	20
Continuous product & process improvement (CPPI)	20
Motivation of employees	13
Total	100

The results of the PCM analysis for each of the techniques above were multiplied by the weights as determined above to yield a raw score for each of the management techniques. The results are shown in the following Table 2.

Table 2
Raw Scores of Management Techniques

CSFs	TQM	SDT	PM	MBO
Cost	4.51	2.64	2.09	1.76
Training	6.12	4.42	3.40	2.89
Communication	8.00	4.40	4.20	3.60
Participation	6.40	6.20	4.00	3.40
CPPI	7.40	5.40	4.40	2.80
Motivation	4.42	3.90	2.86	1.95
Total	36.85	26.96	20.95	16.40

Exhibits 3 and 5 in Appendix B show information in Tables 1 and 2 in graphical format, respectively. Exhibit 5 shows the contribution of each management techniques to each CSF.

D. Relevance of the CSFs

From these results in the previous sub-sections, it is seen that TQM received the highest score while MBO has the lowest score.

Hypothesis number 3 stated that cost is an important factor in implementing a strategic management technique. The results of this report indicate that this is not true. The cost did not factor in very significantly. In all cases except TQM, cost received the lowest raw score. One interviewee stated that, the cost is not significant in their program because they focus on continuous process improvement. Thereby, the costs involved are incremental and can be managed/budgeted effectively.

It is interesting to note that the CSF communicative organizational structures contributed very heavily to the success of TQM, while at the same time being the highest contributor for MBO. The general trend is that the communicative organizational structures is a significant contributor for all of the management techniques, except for the SDT.

V. Conclusion/recommendations

To stay alive in the high-tech business of today, TQM is the most effective strategic management technique. This hypothesis supported by the high score that our analysis gave to TQM. However, implementation of TQM takes a long time. When one of the interviewees was developing the TQM process, it was clear to the management team that they needed to study and research the topic. This company was not interested in adopting the existing parent-company's program package. They knew that they would need a customized program if it was to succeed. The management team, including the General Manager of the plant, planned for over nine months. During the planning stage, they learned from other successful quality management programs such as the Hewlett-Packard, Johnson & Johnson, and other Japanese companies. The philosophy that is practiced everyday by everyone, including the General Manager, is the LUTI concept. LUTI to is Learn, Use, Teach, and Inspect. The Quality Assurance Director of this company emphasized the need to "Walk-the-Talk" and this practice can be observed starting from the General Manager.

For a TQM program to work, the following values need to be adopted:

- The customer comes first
- Quality comes first
- Quality means more than what was planned
- Teamwork, communication and cooperation are critical
- Long-term planning is much better than fire-fighting

These issues were discussed in detail in Section II of this report. It is recommended that any company seeking to embark on TQM program should study and plan diligently. The planning group needs to include representatives from all levels of the organization, especially the general manager.

A. Strengths, Weaknesses, and Areas for Further Study

The strengths of this study is the literature research since all the issues of management, CSF, and the management techniques are studied. Very logical strategic planning approach is used and CSF analysis is done.

The following areas of weakness are identified:

- More time and a bigger sample size would have yielded a better result.
- The topic seems to be too broad. Each management techniques by itself may allow a more detailed study.
- Better statistical techniques can be used for the determination of the appropriate management techniques, as opposed to the PCM method.
- Better CSFs could be identified. Although the issue of mutual exclusiveness of the CSFs was important, one of our respondents indicated that it might not be the case. More research and better analysis could be used.

The study can be expanded upon some specific areas such as R&D, manufacturing, project management, or customer service. A more detailed survey with larger size, can be conducted for the analysis and verification of the results. Further, a well developed statistical technique may be used in the analysis.

Appendix A: Survey Questionnaire

COMPARISON OF SELECTED MANAGEMENT TECHNIQUES: TOTAL QUALITY MANAGEMENT vs. SELF-DIRECTED TEAMS vs. PROACTIVE MANAGEMENT vs. MANAGEMENT BY OBJECTIVES.

This questionnaire is designed by a group of Graduate Student in Engineering Management Program at Portland State University. The purpose of the questionnaire is to identify your subjective judgements on some Critical Success Factors (CSF) and the best management techniques for the US high technology companies to achieve and maintain a competitive edge in global market place. Your name and the name of the organization will be kept confidential.

NAME :
COMPANY :
POSITION:
MAIN JOB:
PHONE # :

Definitions

Total Quality Management (TQM): Long term and top-down management philosophy that focuses on "breakthrough" thinking, a structured, disciplined approach to identifying and solving problems, supported by quality. It is a permanent solution and a way of life.

Self-directed Teams (SDT): Small group of employees responsible for a segment or an entire work process. They are involved in many issues such as management, vendor quality, safety and business planning.

Proactive Management (PM): A management philosophy in which individuals and organizations take the initiative to establish goals and objectives through both long term and short term planning. The individuals appear to be decisive, firm and communicative. They tend to self-initiate contacts both inside and outside of their organization/work group in order to meet their goals and those of the organization.

Management By Objectives (MBO): A process through which individuals in organization work together to identify common goals and objectives, and coordinate their efforts in attaining them. In an MBO process, a supervisor and subordinate attempt to reach consensus on: (1) goals the subordinate will attempt to accomplish during a specified period of time; (2) the means the subordinate will use to reach those goals and (3) the means used to measure and evaluate progress toward the goals. evaluated.

The Critical Success Factors

1. **Cost** refers to installation cost of the management techniques.
2. **Training** means whether the training is necessary or not to institute the management technique. Also refers to the frequency and period of training.
3. **Communicative organizational structure** refers to management style that promotes communication between employees and management. It also refers to the layers of management that might impede flow of information.
4. **Employee involvement** refers to employee participation in the decision making process.
5. **Continuous improvement** refers to continuous process or product improvement.
6. **Motivation of employees** refers to the power of management techniques that motivate and encourage employees.

Questions

1. Do you have any formal training in Quality Control and implementation issues?

2. Are you familiar with the management techniques listed above? (Please refer to the definition page included with this questionnaire.)

3. Rank the CSFs in order of increasing importance from 1 to 6, where 6 is most important.

CSFs	Relative Ranks
Installation cost of management techniques	
Continuous leadership and employee training	
Communicative organizational structure	
Employee participation	
Continuous product and process improvement	
Motivation of Employees	

4. Can you identify other CSFs besides the ones listed above?

5. In the following, compare the Critical Success Factors for the four management techniques. The comparisons are done in pairs. You will be asked to check one of the four choices (1 to 4). For example in comparing TQM v.SDT for the CSF Installation Cost, you will be asked to check 1 to 4 where 1 means least expensive and 4 means most expensive. If in the comparison you decide that SDT is always more expensive then put a (-) sign in front of the checked choice. In the case of the Installation cost example, if you circle 4, it would mean that for Installation Cost, SDT is most expensive compared to TQM.

A. Installation cost:

	Least Expensive	Moderately Expensive	Expensive	Most Expensive
	1	2	3	4
TQM v. SDT	□	□	□	□
TQM v. PM	□	□	□	□
TQM v. MBO	□	□	□	□
SDT v. PM	□	□	□	□
SDT v. MBO	□	□	□	□
PM v. MBO	□	□	□	□

B. How Important is continuous training:

	Not Important	Somewhat Important	Moderately Important	Very Important
	1	2	3	4
TQM v. SDT	□	□	□	□
TQM v. PM	□	□	□	□
TQM v. MBO	□	□	□	□
SDT v. PM	□	□	□	□
SDT v. MBO	□	□	□	□
PM v. MBO	□	□	□	□

C. Does the organizational structure allow for easy communication with upper management?

	Not Communicative	Somewhat Communicative	Moderately Communicative	Very Communicative
	1	2	3	4
TQM v. SDT	□	□	□	□
TQM v. PM	□	□	□	□
TQM v. MBO	□	□	□	□
SDT v. PM	□	□	□	□
SDT v. MBO	□	□	□	□
PM v. MBO	□	□	□	□

D. Compare Employee Involvement in the decision making process:

	Not participative	Somewhat participative	Moderately participative	Very parititipative
	1	2	3	4
TQM v. SDT	☐	☐	☐	☐
TQM v. PM	☐	☐	☐	☐
TQM v. MBO	☐	☐	☐	☐
SDT v. PM	☐	☐	☐	☐
SDT v. MBO	☐	☐	☐	☐
PM v. MBO	☐	☐	☐	☐

E. Compare Employee motivation:

	Not motivated	Somewhat motivated	Moderately motivated	Very motivated
	1	2	3	4
TQM v. SDT	☐	☐	☐	☐
TQM v. PM	☐	☐	☐	☐
TQM v. MBO	☐	☐	☐	☐
SDT v. PM	☐	☐	☐	☐
SDT v. MBO	☐	☐	☐	☐
PM v. MBO	☐	☐	☐	☐

F. How do the different management techniques help maintain continuous product and process improvement:

	None	Somewhat	Moderate	Very
	1	2	3	4
TQM v. SDT	☐	☐	☐	☐
TQM v. PM	☐	☐	☐	☐
TQM v. MBO	☐	☐	☐	☐
SDT v. PM	☐	☐	☐	☐
SDT v. MBO	☐	☐	☐	☐
PM v. MBO	☐	☐	☐	☐

6. What else do you think the US high-tech industries need to do to achieve and maintain a competitive edge in the global market-place?

Appendix B: Exhibits

1. TQM Model
2. MBO Model
3. Relative Weights of CSFs
4. Contribution of Management Techniques
5. Raw Scores of Management Techniques

TQM Model

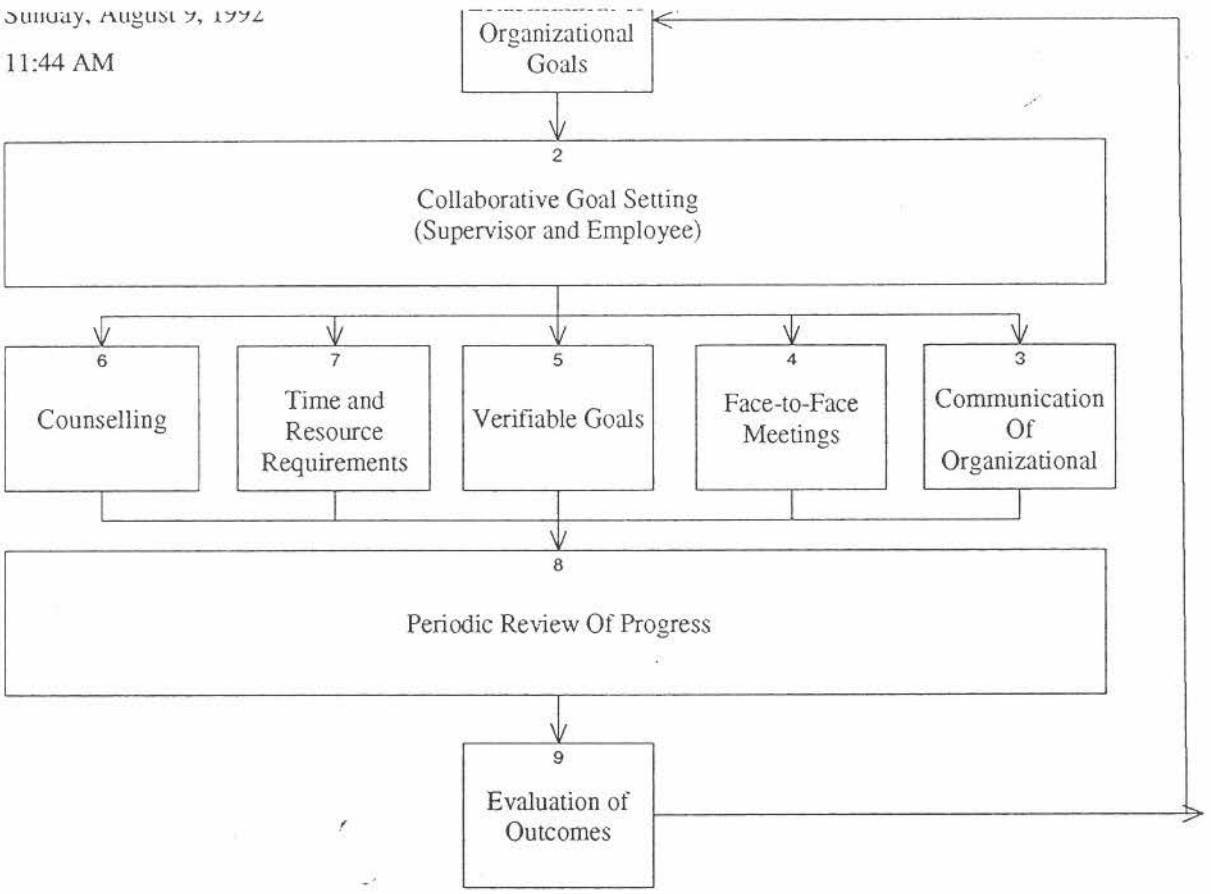
1. Recognize need
2. Commitment
3. Organization and Resources
4. Plan
5. Benchmark Current Performance
6. Define Targets
7. Identify Source of Variation
8. Deploy Quality Goals8.
9. Methods of Controls & Performance Measurement
10 Process Experimentation
11. Process Change
12 Reestablish Benchmark
13. Begin Cycle Again

Source: Recognizing the Pitfalls of TQM, Robert Laza, P. Wheaton in Public Utilities Forthnightly, April 12 1990

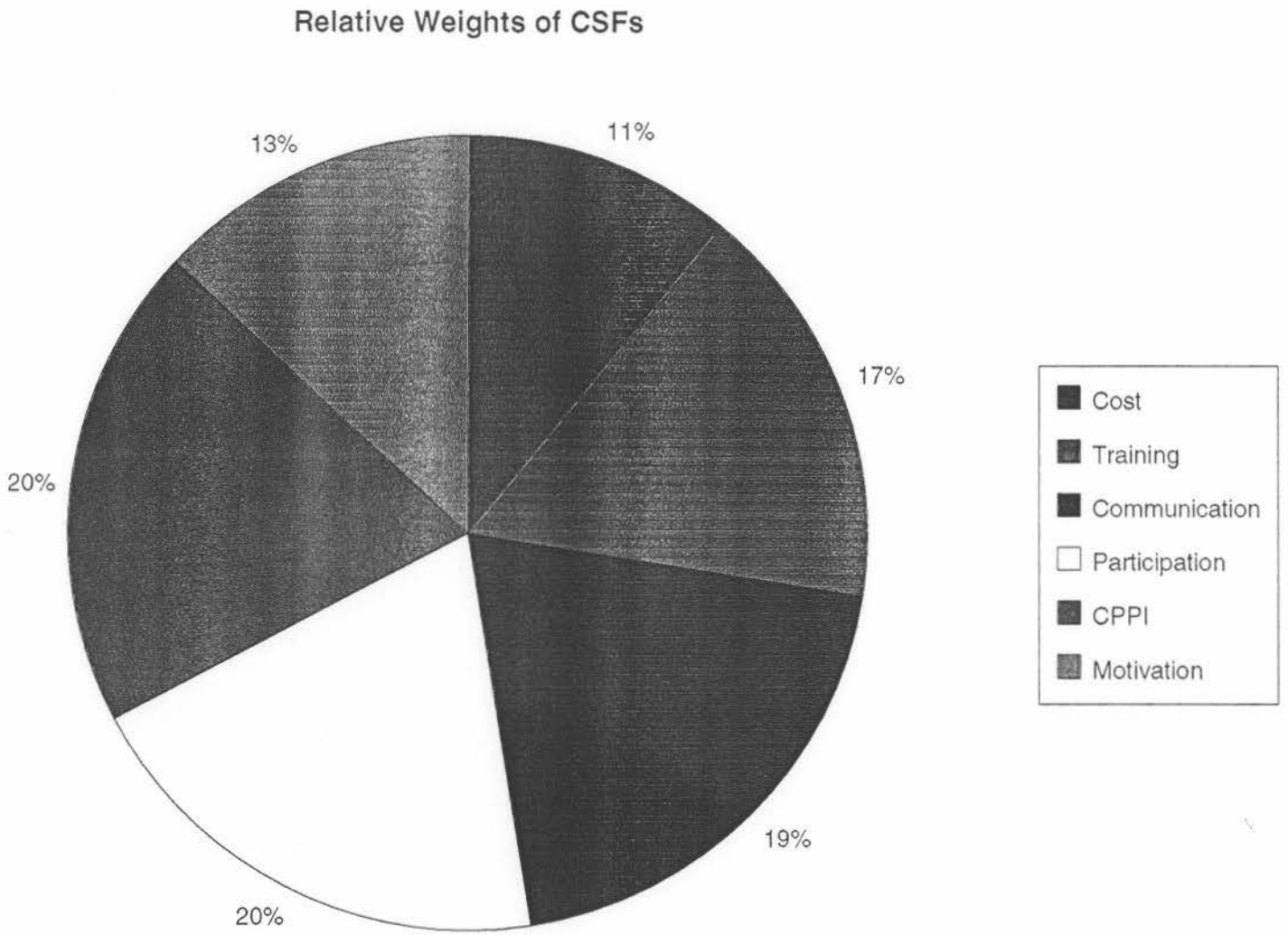
MBO Model

Sunday, August 9, 1992

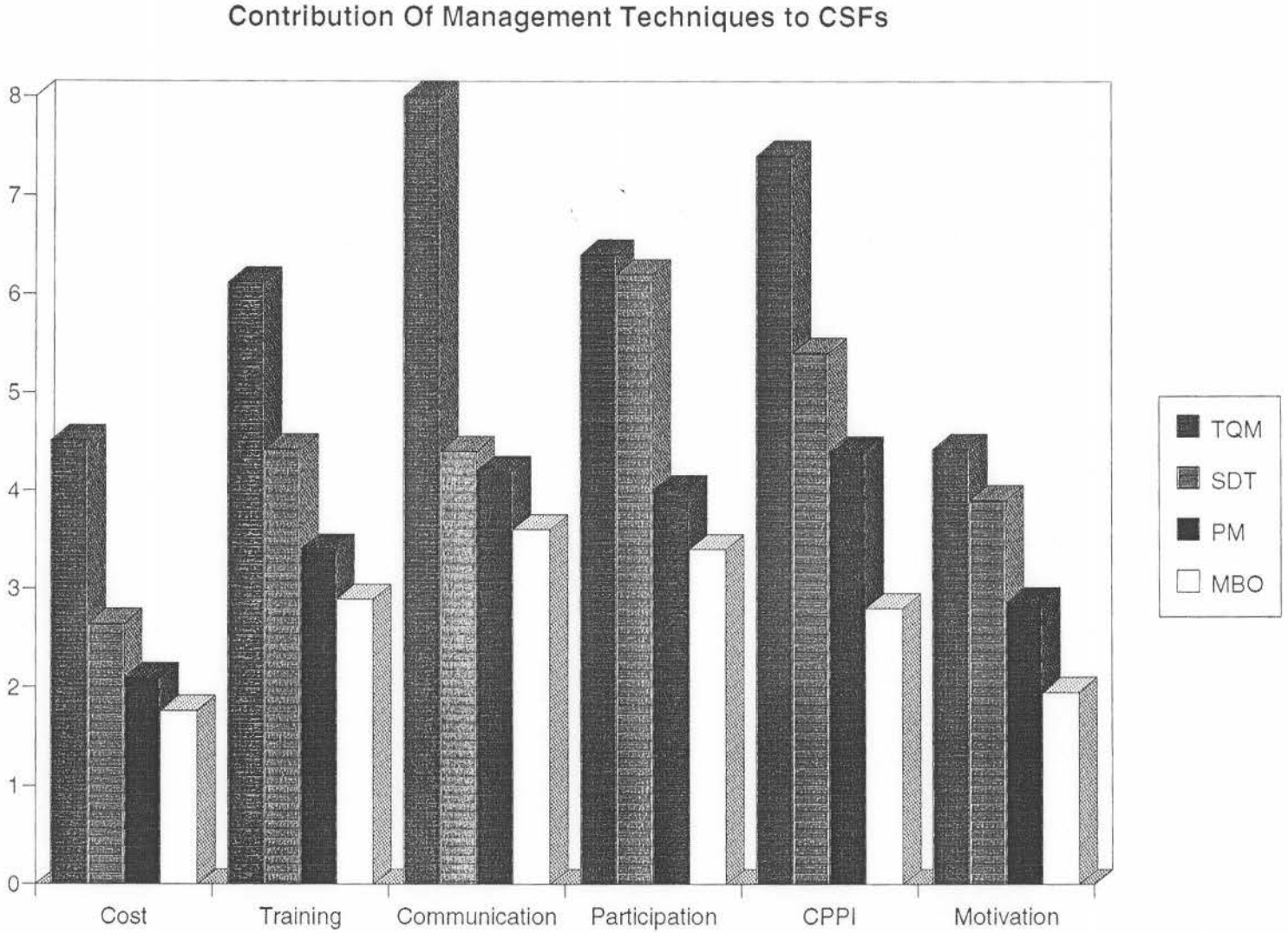
11:44 AM



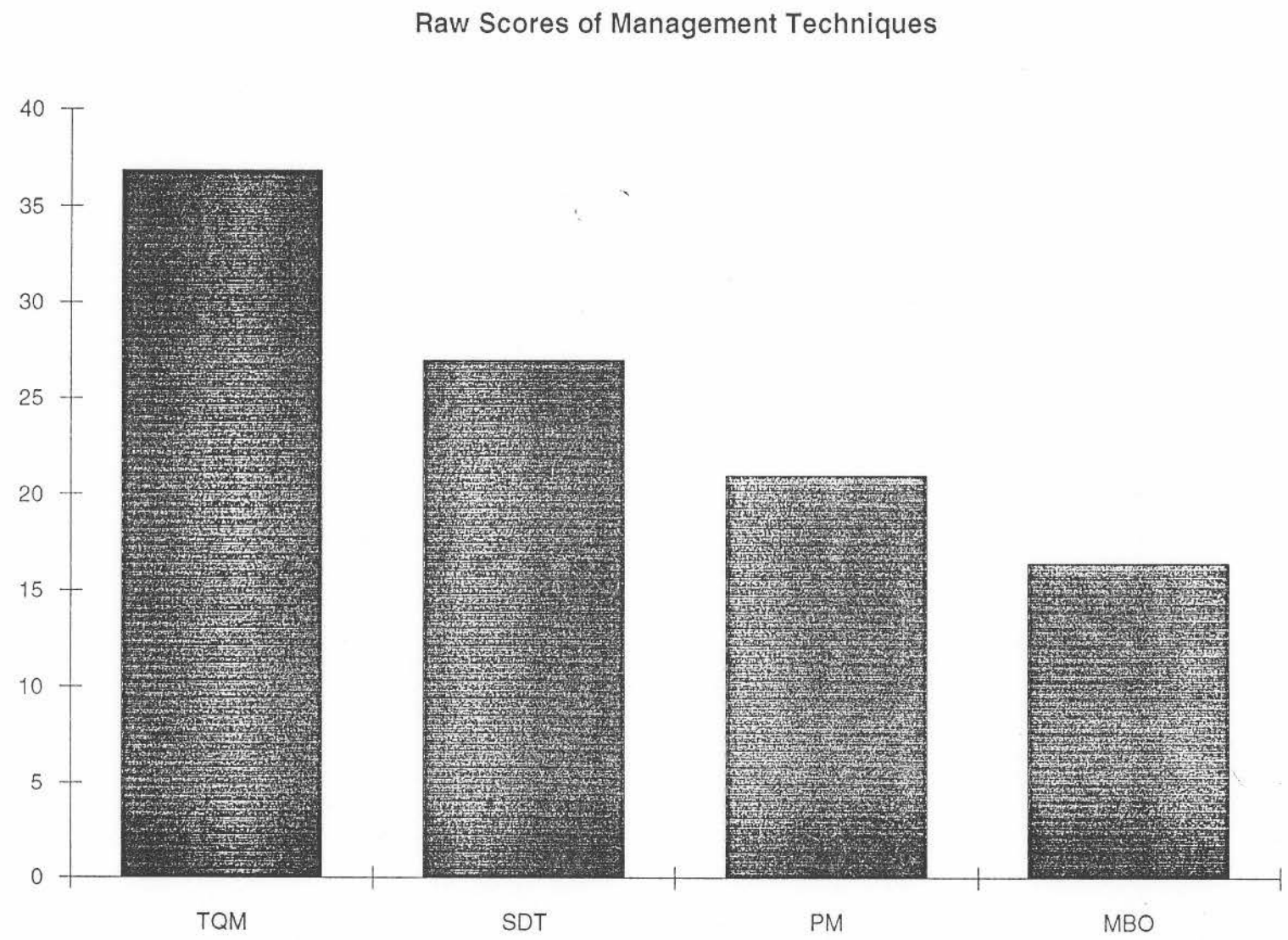
Relative Weights of CSFs


Relative Weights of CSFs
11%
17%
19%
20%
20%
13%
Cost
Training
Communication
Participation
CPPI
Motivation

Contribution of Management Techniques


Contribution Of Management Techniques to CSFs
8
7
6
5
4
3
2
1
0
Cost
Training
Communication
Participation
CPPI
Motivation
TQM
SDT
PM
MBO

Raw Scores of Management Techniques


Raw Scores of Management Techniques
40
35
30
25
20
15
10
5
0
TQM
SDT
PM
MBO

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