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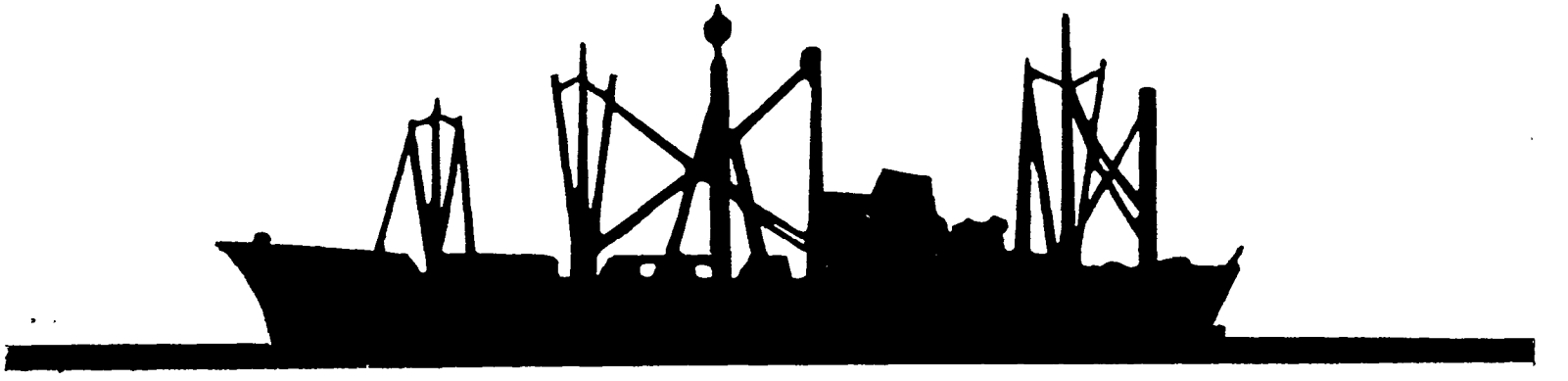

INSTITUTE FOR RESEARCH AND ENGINEERING FOR AUTOMATION AND PRODUCTIVITY IN SHIPBUILDING

I R E A P S

THE UTILITY OF QUALITY CIRCLES AND PRODUCTIVITY TEAMS IN U.S. SHIPBUILDING

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ABSTRACT

Quality circles have been found to improve productivity an average of 12% in 3 to 6 months in a controlled research pilot study performed by Business Innovations, Inc. for the U.S. Department of the Navy. Human relations and job satisfaction were also found to improve within a few months of starting quality circles at four companies. Quality circles (QC's) have been adopted widely by U.S. and Japanese industry and are increasingly finding acceptance in U.S. industry, including shipbuilding. The average return on investment for quality circles is 6 to 1. QC's are a simple, but effective, technique for problem solving which involves employees and increases motivation, communication, and productivity. They are a phenomenon of group dynamics not quality control techniques.

Implementation of quality circles needs to be carefully planned and should involve all levels of management and employees. An alternative to quality circles at foreman and management levels is "productivity teams". These involve more sophisticated training and the use of industrial engineering techniques. Productivity Panels and quality circles area low cost, high return investment for shipyards to cut costs and turn around companies with lagging sales due to decreased international competitiveness.

INTRODUCTION

I would like to begin by asking how many of you are responsible for growth in productivity in your company? I think that includes all of us. Today I would like to discuss a way for you to receive the help and involvement of every employee in your company in contributing to productivity growth. That way is a new organizational activity called quality circles.

Quality circles, have been successful in organizing and motivating the human resources of companies to improve productivity and quality control in many industries, including shipbuilding in Japan, and more recently the U.S. Business Innovations recently performed a pilot study for the Department of the Navy on QC's from four U.S. companies including shipbuilding, electronics assembly, construction materials, and textiles. Initial conclusions showed that quality circles improved productivity an average of 12% within three months. The return on investment (ROI) of the circles in shipbuilding was 600%. Quality circles were also found to improve communications, cooperation, and job satisfaction, and to increase perceived importance of tasks and personal influence of employees as measured by pre- and post-test surveys.

Data from the study indicated success of circles depends on changes in organizational behaviour and employee perceptions which reduce barriers to communication and collaborative purposeful activity. Strong management support, professional training, talented program coordinators (facilitators), and open communications between circles and other departments are needed to effect these changes. Success does not depend on work situations, type of manufacturing, or characteristics of workers. Both union and non-union workers, as well as white collar, blue collar and management circles were equally effective.

Another finding of the Business Innovations study was that a quality circles type of structure of organizational relationships is needed at the management level. These are often called productivity teams because their scope is considerably broader than that of quality control. Productivity teams involve foremen, superintendents, department heads and upper management, instead of just employees. They use more sophisticated problem solving tools, including industrial engineering techniques. Productivity teams complement quality circles by creating effective problem solving groups at the management level which can interface with quality circles to create company-wide improvements in lateral and verticle communications, collaboration, and optimization of interdepartmental effectiveness.

WHY WE NEED QUALITY CIRCLES IN SHIPBUILDING

The objectives of quality circles and productivity teams are ultimately to minimize cost and lead time of shipbuilding, repair and manufactured fabrications in shipyards. Presently, productivity is low due to problems arising from low worker motivation, material shortages, slow response from service departments, outdated tooling, parts below specification, scheduling and engineering problems, etc. These problems manifest at the waterfront job site and are experienced directly by workers and production management. They are therefore identifiable by foremen and their work crews.

However, many of these problems are often not recognized by upper or middle management prior to the slow down or work stoppage. The people in the work force know what is interfering with task completion, but this is often not presented to management in a usable way. Furthermore, the priorities of departments which should solve these problems are often directed toward projects dictated by upper management. Thus, lateral cooperation with work crews of other departments to maximize productivity and optimize total company output is lacking. No communication channels currently exist for these problems to receive the prompt attention of those persons in middle management whose involvement is necessary to help solve them and raise productivity.

Furthermore, foremen generally lack training in ways to improve productivity through the use of industrial engineering techniques, human motivation and group dynamics, quality control and problem solving skills. The foremen are key people who are in a position to improve productivity, yet they are not given the training or concepts of how to analyze and communicate their needs to superiors or subordinates. The consequences are poor productivity, high stand-by time, delays, cost overruns, reduced quality of finished product, low worker morale and decreased competitiveness of U.S. shipyards in the face of mounting international competition. It was concluded in SNAME SP8 report, Task EE-2 of l/17/82 that increased training in productivity improvement techniques for foremen and supervisors, and better communication channels between management, industrial engineering, and labor are the most needed management techniques at the members' shipyards.

Many of the types of problems faced by foremen, superintendents, and department heads can be solved by quality circles or productivity teams. Furthermore, many of our current problems with employee motivation occur due to the failure to use principles of human behaviour which quality circles employ. Quality circles are especially applicable to shipbuilding because so much of the work is worker-paced rather than machine-paced and because interdepartmental coordination is so important. Furthermore, quality is

difficult to inspect in shipbuilding and expensive to correct if the job is not performed properly the first time. Quality circles and productivity teams directly address these well-known problems.

DESCRIPTION OF QUALITY CIRCLES

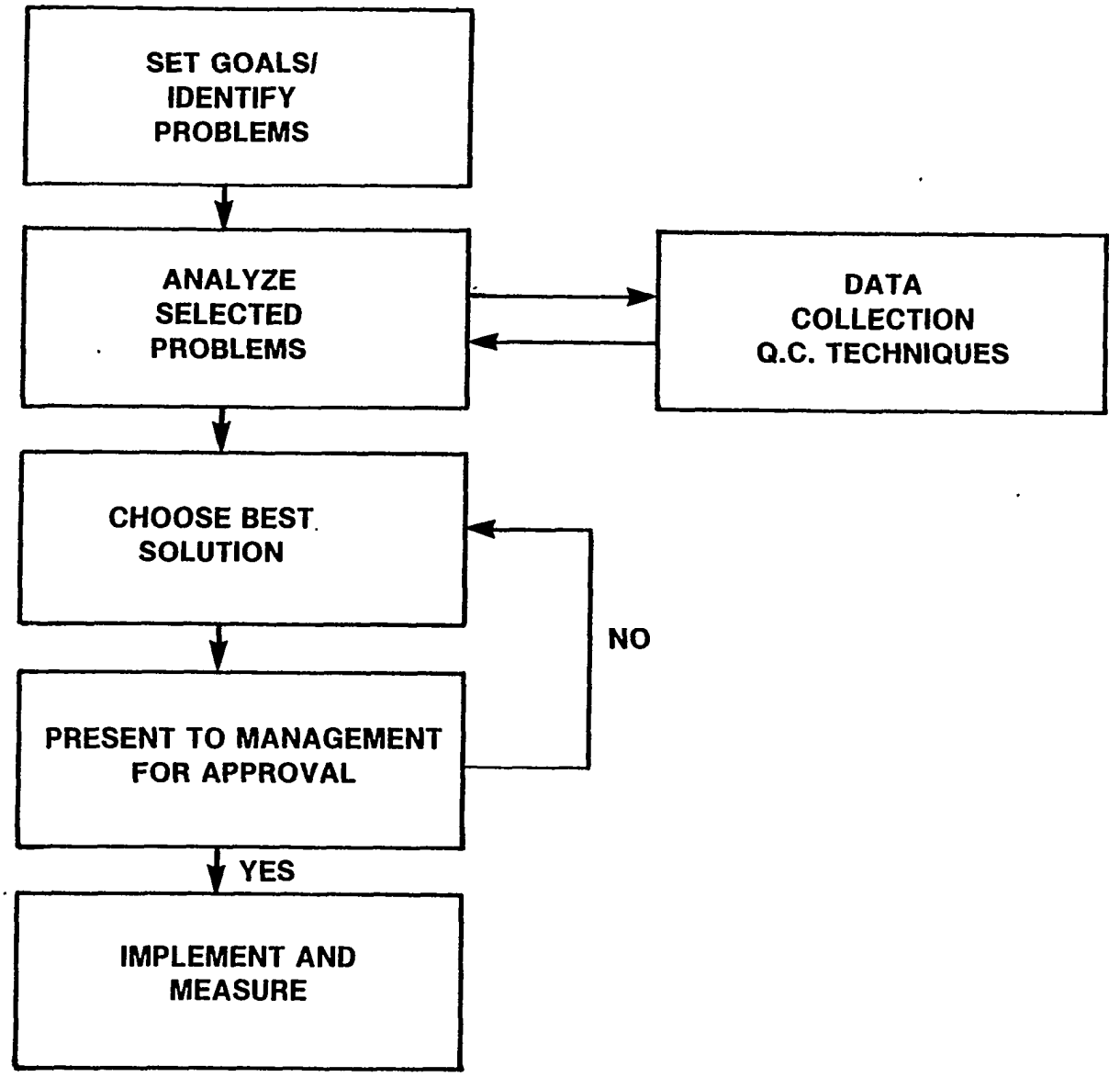
Quality circles are a technique of participative problem solving. They usually include 5-15 employees from the same department who meet for an hour a week with their foreman or superior to identify, analyze and solve problems which improve productivity, quality, or organizational effectiveness. Members may be employees, trades people, draftsmen, purchasers, secretaries, engineers or managers. Each circle has a leader who is usually the person in the chain of command to whom the circle members all report. The key element of quality circles is their emphasis on consensus decision making and the expertise of the person closest to the problem, usually an employee.

The activity of quality circles begins with the voluntary agreement of the members to participate. The group then sets overall goals which are related to objectives of the company. Improvement of productivity, quality, safety, or quality of work life are typical goals. Next the group identifies problems which, if eliminated, would help achieve the goals. The circle members choose by consensus which problems to work on. In so doing they take responsibility for the achievements of the group. This increases commitment of the group members to achieve the stated goals. The selected problems are then analyzed using techniques developed or adopted by quality control experts. These include check sheets, control charts, cause and effect analysis, pareto analysis, stratification, histograms, and scattergrams. They are all relatively simple applications of statistical analysis of quality control data. They introduce the element of the scientific method to the group's problem solving activities.

These analyses create a focus for generating solutions *to* the problems. For instance, the average waiting time for tools at one yard was found to be 12 minutes. The time loss was obviously great enough to warrant creation of additional distribution windows. In another case, on using Pareto analysis, 80% of the rejects were traced to two malfunctioning machines. Page seven is an illustration of a Pareto analysis of tubes out of tolerance.

Once the cause of the problem has been identified possible solutions are generated by group brainstorming. These creativity stimulating sessions often produce innovations which could even appear in technology transfer

HOW QUALITY CIRCLES WORKS



programs or conferences such as this. Thus, quality circles are an innovation in human engineering which sets all minds in the corporation to continuously creating new productivity or quality improving innovations.

Once the best solution has been agreed upon, the entire quality circle makes a well rehearsed presentation to management. This is a valuable vehicle for employees to communicate their needs to management. Thus, another principle of quality circles is that decisions are made at the lowest level possible and are communicated upwards in the chain of command for approval. This creates two-way communication up and down in the organizational structure. QC's receive approval from management to implement their recommendations 80% of the time. The implementation is performed by the quality circle itself whenever possible, but the job is not complete until measurements are taken to demonstrate to what extent the problems have been solved.

QUALITY CIRCLES IN SHIPYARDS

Quality circles were first adopted in the United States by Honeywell and Lockheed about 1974. Their success there and in Japan has led to their wide-scale adoption by about 2500 U.S. companies in the past three years, including well-known Fortune 500 companies. Among shipyards, the Norfolk Naval Shipyard was the first to adopt quality circles in 1979 and today has the largest program with about 60 circles. Since then, several other naval shipyards and three major commercial yards have experimented with quality circles.

The largest program in the private sector was started in 1980 at Lockheed Shipbuilding and Construction Company and currently has 36 circles. Several other shipyards have pilot quality circles programs or are planning to implement quality circles. Most of the major Japanese yards also have quality circles or their equivalent and have reported significant savings in costs as well as improvements in worker morale. One Japanese yard, IHH, has integrated quality circles style of functioning into the management system so completely that quality circles are no longer a separate activity.

Three of the U.S. shipyards have calculated return on investment of their quality circles programs. To do this the costs of training and meeting time plus costs of quality circle projects were subtracted from actual or projected savings from improvements made by quality circles. The following table shows the results to date:

Yard	Date Started	# Circles	ROI
Norfolk Naval Shipyard	1979	60	325%
Lockheed	1980	36	400% in 1981
			1000% in 1982*
Newport News Shipyard	1982	8	600%*
Bethlehem Steel (Sparrows Point)	1982	3	NA
Peterson Builders	1981	9	NA

*Projected Savings

These results are similar to the U.S. national average of benefits to costs ratio for quality circles in all industries which is 6 to 1. In addition to these calculated cost savings many circles improve productivity, product quality, and other aspects of work flow which save money and increase profitability but are not normally documented. In Business Innovations' study for instance, one company improved productivity 13.4% in quality circles compared to control groups. This occurred in just three months time, long before any calculated cost savings due to specific quality circles implemented projects could be calculated.

Two circles in timekeeping at the shipyard in the study reduced rejects 14% in six months. Two circles in a purchasing department at the shipyard increased productivity 23% versus a 20% increase in control groups in three months while still planning, but not yet implementing any cost savings programs. These results show that quality circles increase motivation, since no procedural changes had yet been implemented. In addition to cost savings, quality circles were almost universally found to improve morale, job satisfaction, and communications with management.

Some examples of cost savings projects of quality circles in our study were:

1. Elimination of redundant approval checks on low-cost purchases. Savings: $500,000/year.

2. Reduction of inaccurate time cards through consultation with foremen. Savings: $55,000/year.

3. Elimination of a production step by designing a reusable chamfer for concrete slabs.

Norfolk Naval Shipyard gives the following examples of quality circles achievements:

1. Increased number of outlets in the tool room to reduce waiting time. Savings: $200,000/year.

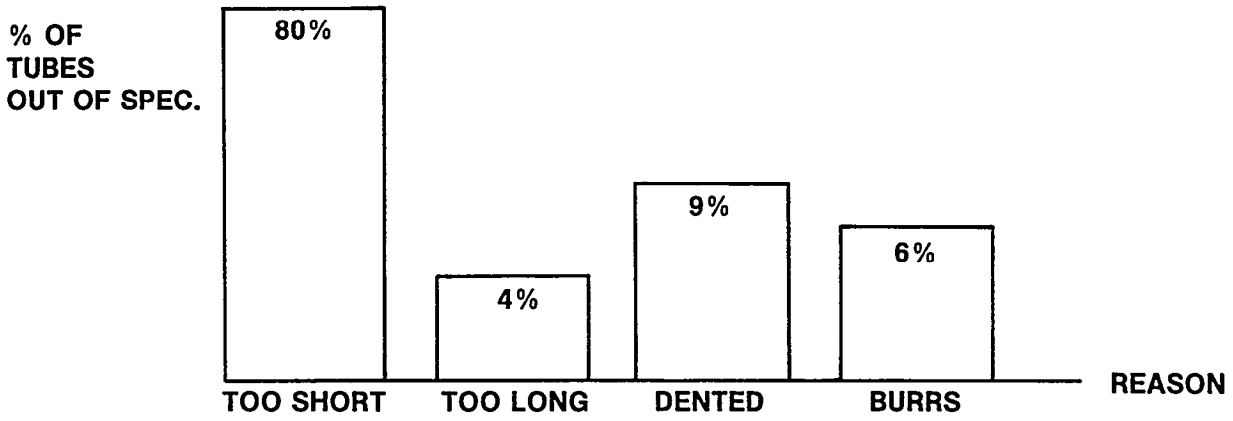
2. Movement of electrical stations. Savings: $10,700/year.

Lockheed Shipbuilding and Construction offers these examples of quality circles projects.

1. Re-examintion of sandblast material. Improved surfaces and saved $68,000/year in wasted material.

2. The welding circle developed a process to use weldable zinc primer. Savings of several thousand manhours/year.

PARETO ANALYSIS



METHOD OF IMPLEMENTATION

Although the format of quality circle activity described earlier has been universally adopted, the method of implementation varies according to the work situation and is important in how successful quality circles ultimately become at raising productivity. The first step in implementation is for the company to learn as much as possible about quality circles. Quality circles involve changes in bahaviour, attitudes, values and sometimes organizational culture which should be fully understood before they are implemented. A steering committee made up of representatives from every level of management and employees, including union stewards if employees are unionized, should be created to plan the implementation of quality circles and to set guidelines. Representation by all levels helps the committee foresee problems and improves commitment to the program at all levels of the organization. Since every level of management and employees will be affected by quality circles, it will be necessary to plan a program to increase awareness of what quality circles are and how they can benefit the company. This publicity will also be instrumental in ensuring that quality circles are well received and seen as an opportunity rather than a threat.

At this point a company may wish to involve a consultant who is expertly trained in behavioural sciences and quality circles. The consultant can help the steering committee in the above tasks as well as in selecting the facilitator, training the circle leaders and trouble shooting any problems that may occur during the start-up phase. The selection of the in-house facilitator or program coordinator is also critical because the circles are often dependent on him initially, and he is their chief liason with management. While most facilitators are successful, those trained in behavioural sciences were found in our pilot study to have generated the most outstanding examples of successful quality circles programs.

For several reasons a pilot program of less than ten circles usually precedes full scale implementation. This allows all concerned to become familiar with quality circles slowly. The most important implementation step is training. The circle leaders and facilitators receive about three to five days of training in problem solving, group dynamics, and quality control analysis techniques which they then impart to their circle members as needed. The training includes all of the knowledge and materials quality circles need to perform each step in the problem solving process.

FACTORS AFFECTING SUCCESS OF QC'S

While the majority of quality circles implemented are successful, many circles and some entire company circles efforts do not succeed. The reasons for failures vary, but the most often cited problem is lack of support from all levels of management. Because quality circles involve changes in basic assumptions about how managers should interact with subordinates, many people feel threatened by quality circles and/or do not believe they will work. The best solution to this problem is to involve management in quality circles directly or in other organizational change programs which utilize principles of participative teamwork. The Lockheed Shipbuilding quality circles, for instance, are just one of several organization renewal programs at that company which together work to improve the use of principles of communication, collaboration and motivation in organizational behaviour.

Quality circles which involve department heads, superintendents, and engineers have been very successful at Peterson Shipbuilders, Lockheed Shipbuilding, Norfolk Naval Shipyard, and at other companies in Business Innovations' study. Also, circles in non-managerial white collar professional areas are particularly common in shipyards. These are found in engineering, planning and control, scheduling, drafting, timekeeping, data processing, etc. Not only were the management and white collar level circles able to take on problems of much greater scope than employee level circles, but because of their own experience, the managers who were quality circle members became highly supportive of other circles lower down in their departments. This usually occurs because people who become involved in quality circles or similar participative group activity experience an unusual increase in energy, creativity, cooperation, and progressive change. This is not a normal occurance in U.S. organizations which today encourage isolated, competitive individual activity rather than cooperative group dynamics.

Managers, who may originally be skeptical, quickly see that quality circles do not cause a loss of control due to their participative nature; they actually strengthen the chain of command by improving communications and mutual respect. If line managers in the departments where quality circles are created cannot participate in a circle of their own, they should at least receive training to familiarize themselves with quality circles methods so that they can assist circles in their departments when they need help. The importance of the involvement of management cannot be over-emphasized.

It should be clear that quality circles succeed because of the group dynamics they generate, not the use of quality

control techniques. Thus, this phenomenon which produces improved productivity and human relations at once is applicable to all levels of the organization. It should also be possible to create similar types of groups or teams at higher levels of management using more sophisticated industrial engineering (IE) techniques of analysis such as methods improvement, value and functional analysis, work simplification and short interval scheduling as needed. Lockheed Shipbuilding has attempted to accomplish this by having an industrial engineer meet with each quality circle as a resource person. The use of these IE techniques would be even more logical at management levels including foremen, since the problems they address and their analytic abilities are of a broader scope than employee-level quality circles.

Productivity teams at the foreman level and above could be as widely implemented as QC's at the employee level. It would seem that an even greater ROI could be obtained from productivity teams than QC's, since management controls about 85% of the factors influencing productivity, and employees control only 15%. The involvement of management in productivity teams would, according to our research, create the support needed to make the principles of human organizational behaviour at work in quality circle types of activities successful at all levels of the organization. By taking this approach, Lockheed Shipbuiilding was able to increase its return on investment in QC's from 400% in 1981 to 1000% in 1982.

The second most important factor affecting success of quality circles is training. In our research we have found that training in group dynamics and the steps of problem solving are more important than the use of any quality control techniques of analysis. Some consultants mainly emphasize these quality control techniques, but several of the most successful programs, including Honeywell and Lockheed Shipbuilding, use very few of these techniques.

Like management involvement, union involvement is also a factor to be considered. Because quality circles give employees an opportunity to improve their jobs, employees are usually receptive. Most unions will cooperate or at least remain neutral about quality circles if consulted early on, since quality circles are so popular with employees.

An on-going tool to maximize results from quality circles programs is recognition of their achievements. Newsletters, awards, luncheons, and cash reward participation (as in suggestion systems) are all used widely to give recognition to the most successful quality circles.

A fifth aspect of quality circles functioning which is important to promote is the cross collaboration between

circles in different departments. Lockheed Shipbuilding more than doubled ROI from circles in 1982 partly because a sufficiently large number of circles operating in different departments were able to communicate directly with each other, whereas individuals would have had to go through multiple levels of hierarchy to achieve the same objectives.

CONCLUSIONS
REASONS FOR QUALITY CIRCLES AND PRODUCTIVITY TEAMS

1. Quality circles cut costs, increase productivity, quality and improve employee-management relations. They produce results quickly, within a few months.

2. QC's and productivity teams are a low cost investment, under $30,000, and they have a faster, higher return on investment than most automation projects.

3. QC's are especially applicable to shipbuilding because shipbuilding is worker paced and quality is difficult to control.

4. QC's and productivity teams create an atmosphere of communication, motivation, and involvement. They maximize the use of companies' human resources. This is the basis of productivity improvement, innovation and future competitiveness in international markets.

5. Productivity teams and quality circles are needed for future international competitivenes..