A Study on the Conceptual Differences between Total Quality Control and Total Quality Management
품질관리와 품질경영의 개념적 차이에 관한 연구

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Abstract

This study was aimed at reviewing the conceptual framework characterized in the Total Quality Control and the Total Quality Management. It has been observed in recent years that the term TQC and TQM tend to be used interchangeably without paying much attention to whether the two concepts have identical meaning, or they are as similar as can be applied indiscriminately to the same objectives in handling quality issues. To distinguish between the two, this study relied on reviewing quality definitions, techniques frequently resorted to, and the main themes implied by each of them. It was concluded that they differ in terms of both techniques and themes, and are not to be applied interchangeably to the handling of the same quality objectives and problems.

1. Introduction

When the concept of Total Quality Control was first introduced in the early 1950s, scholars and practitioners in the field expected that it would make a tremendous impact on the enhancement of product quality because, compared to Statistical Quality Control, it was much broader in the coverage of organizational element, and more thorough in defining the meaning of quality. More than four decade-long application of it so far has proven that the expectations were not illusions.

In the beginning of the 1990s another seemingly similar term emerged, and has come into wide-use: the Total Quality Management. Yet no few field professionals, even academicians, feel confused with the meaning of the two concepts: it is not clear whether TQM is a merely recoined version of TQC, or it is called so because it resorts to a wider variety of management-level technologies than does TQC, or whether the two see quality differently. On the other hand, some managers and professionals seem to identify TQM with management itself[Toshiyuki, 1985]. In other words, some tend to consider these two as synonyms, while others distinguish them. One of these views must be wrong. If the wrong one be left out unattended, it can hinder the effective utilization of TQM: it can be recklessly applied like a panacea, or remained with a partial accomplishment of the goals and objectives intended to. Another aspect which call attention comes from the ambiguity lying between corporate strategies and TQM practices: how does it contribute to corporate strategies in the process of their formulation? Closely linked to a corporate strategy is competition, and is now a phenomenon widely diffused throughout the industry of virtually all kinds today. Considering that quality is one of the most critical factors winning or loosing competition, and competition can be classified into control and management level, one may suppose that TQC has expanded to handle the management-level competition, and thus the term

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TQM took place for a more precise delineation of the changing nature of TQC. To make clear the conceptual vagueness discussed above, this study hypothesized that TQM is neither a merely renamed version of TQC, nor management itself. To test this, the analyses focused on the definitions, technologies, and the strategic implications of manufacturing. Here the concept of TQC was confined to Feigenbaum's theoretical framework[Feigenbaum, 1986].

2. Conceptual Perspective

To move forward in search of answers to the problems raised in the introduction, it is necessary to go over the definitions and propositions of world-wide recognition. The word quality easily connotes its tacit meaning. But the meaning's conceptualization on a professional workable level is complex and intricate.

Feigenbaum defines quality as the total composite product and service characteristics of marketing, engineering, manufacture, and maintenance through which the product and service in use will meet the expectations of the customer[Feigenbaum, 1986]. The word "composite" here includes reliability, serviceability, maintainability, and other related attributes. Meeting the customer expectations is the focal point of his proposition, and the collaboration among the related organizational functions is the indispensable element to achieve his meaning of quality. Other definitions frequently referred to are fitness for use[Juran, 1974]; conformance to requirements[Crosby, 1979]; the degree to which a product or service is fit for the specified use[Seghezzi, 1981]; the degree to which product characteristics conform to the requirements placed upon that product, including reliability, maintainability, and safety[Swiss Standard Association, 1981]; the totality of features and characteristics of a product or service that bear on its ability to satisfy given needs[EOQC, 1981]; all those planned or systematic actions necessary to provide adequate confidence that a product or service will satisfy given needs[ANSI/ASQC, 1978]. Only a slight difference is found between the two definitions: "Conformance to requirements" and"Fitness for use." The former tends to view high quality as synonymous with meeting specifications, implying that producing a defect-free product or service is essential. The latter is more consumer-oriented, for it stresses on the customer needs in the first place. This definition implies that quality is the judgment of the beholder, and a product or service is deemed to be good to the extent to which it meets the needs of the user. The definitions enumerated above were all made in the two decades through 1970s and 1980s during which the term TQC was in popular use. Entering the 1990s, however, it gave its way to TQM, and isn't often spoken of now. Yet TQM is found to largely rely on the same quality definitions as TQC bore on through the past two decades.

3. Methodological Perspective

Relying on the same definitions doesn't necessarily mean relying on the same technologies. Even if TQC and TQM be assumed to share the same technologies, the range of the methodological alternatives resorted to and the depth of the application can vary. It is worth therefore reviewing some of the most frequently used technologies to help comprehend how the two concepts are similar and dissimilar.

As widely known, the first systematic approach to quality began to take form in 1920s: the Statistical Quality Control. This approach focuses on inspection and measurement of quality based on the theories of variation, special and common causes, and statistical control charts. SQC has a host of analytical tools known as the seven quality control tools comprising pareto diagram;

cause-and-effect diagram; flow chart; check sheet; histogram; scatter diagram; graphs and charts. Normal distribution and the related statistical measures are the important thoretical bases of this technology. Plus-minus 3 sigma from the nominal value has long been used as control limits and quality goals. Conformance to design specification, rather than satisfying customer needs, has been the major concern of these methods. Though these statistical methods are also used for both TQC and TQM, quality goals expressed in variance is under change: some world-class manufacturers, Motorola, IBM, Sony, and Signetics for example, began to dare challenging six sigma process capability, a measure of quality equivalent to 99.9999998 percent defect-free products or 3.4 defects per million products, that is hardly thought to be within SQC potential. Figure 1 shows this changing trend of quality goals.

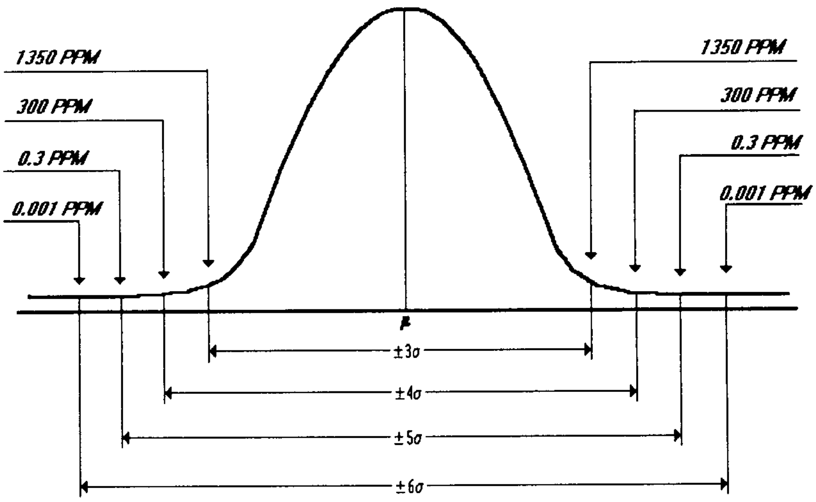

Fig. 1. A comparison of process capability compared to specification tolerance limits.

The Quality Function Deployment is a fairly new invention. QFD is a systematic approach to excavating customer needs rather than to measuring quality variation or to designing sampling plans, and is much concerned with quality planning.

To plan quality in line with customer needs and a firms's manufacturing capability, it heavily depends upon verbal and technical data, combining them into a specially designed matrix-type diagram. This diagram, in a sense, is an operational map of the quality battle, where satisfying customer needs is the key to win. Unlike the conventional statistical approaches that compare products with their design specifications to decide the qualities good or bad, QFD determines a product concept before the hardware design takes place. Essentially, the purpose of QFD is to search for and to determine particular customer needs placed on a specific product feature like price, warranty, operating costs, appearance, etc. There are three steps in implementing QFD:

(1). Collecting information on customer needs. This is usually done through words spoken by customers.

(2). Sorting and classifying the collected data, and creating a structured list.

(3). Relating the customer needs to product design parameters with respect to company goals and technological capabilities.

In the first step, the most heavily involved is the marketing function, where as the manufacturing function usually does the second step. The step three is done by the interwinding efforts virtually of every function and level in an organization, plus suppliers' and customers' help.

One of the most challenging goals of QFD is to accurately translate vague, nonmeasurable customer reguirements into specific product features. To achieve this, it relies on a group of construct and development activities. Of them the central construct that signifies the most distinctive nature of QFD is the House of Quality, a matrix-type diagram mentioned earlier. This diagram consists of a several components:

(1). Customer needs - normally based on words, and developed with Tree Diagram Methods.

(2). Product features - normally based on designers' knowledge of products and structured using Tree Diagram Method.

(3). Planning matrix - for recording the assessment of a variety of factors that combine to rank-order the customer needs.

Taking these procedures, managers and engineers get to know what the real customer needs are and how much important each need is to the customers themselves, the company they are working for, suppliers, and competitors. Having known these, they will be able to grasp a more precise picture of how to adapt their company resources to designing a product matching the defined needs. Figure 2 shows how data are organized on a QFD construct. In Fig. 2, the "What" part identifies customer needs, and is done by a joint effort of designers and customers. The "How" part includes the engineering feature whose relationship to each customer need identified in the "What part" is to be shown in the "Relationship matrix". The "Competitive assessment" parts are done in two ways: the customer rating shows the relative quality of a product in concern relative to its competing products; the competitive benchmarking shows the comparison of the engineering data collected from competing products. The competitive benchmarking differs from the customer rating in that it contains physically-measured data of a product where as the customer rating reflects a customer's perception on the product's quality.

In a word, QFD is a product planning tool to win customer satisfaction. Why customer satisfaction? Aside from an ethical point of view, a company with products gaining no customer satisfaction cannot penetrate into, even survive in, today's highly competitive markets. Then why was QFD originated in Japan? It might be entirely by chance. Otherwise, as it is a more realistic assumption, one probable reason might be that many of Japan's products that won shares in the global markets were either U.S. inventions, or those products whose market share were once held by U.S. companies. Newly invented and staying at the growth stage of product life cycle, U.S. products sold very well without a number of major competitors. Japan, however, as a late-comer, had to penetrate into already established markets of U.S. manufacturers. It is therefore quite realistic for one to suppose that Japan found approaching the customer needs and better satisfying them than could their competitors a sound penetrating strategy, and this was the main impetus of their inventing of QFD.

Taguchi introduced the theory of Quality Loss Function. Taguchi advocates that, by QLF, the cost of deviating from nominal value represents a loss even though the deviation from the nominal value may be within statistically acceptable limits, and the loss increases with the degree of deviation[Taguchi, 1989].

The QLF is $L(y) = K(y - m)^2$

Where L is the loss caused by a deviation from a nominal value m of a product quality characteristic y, and K is a constant established by each company. More specifically, the loss is composed of the loss of business resulting from customer dissatisfaction: the loss to the

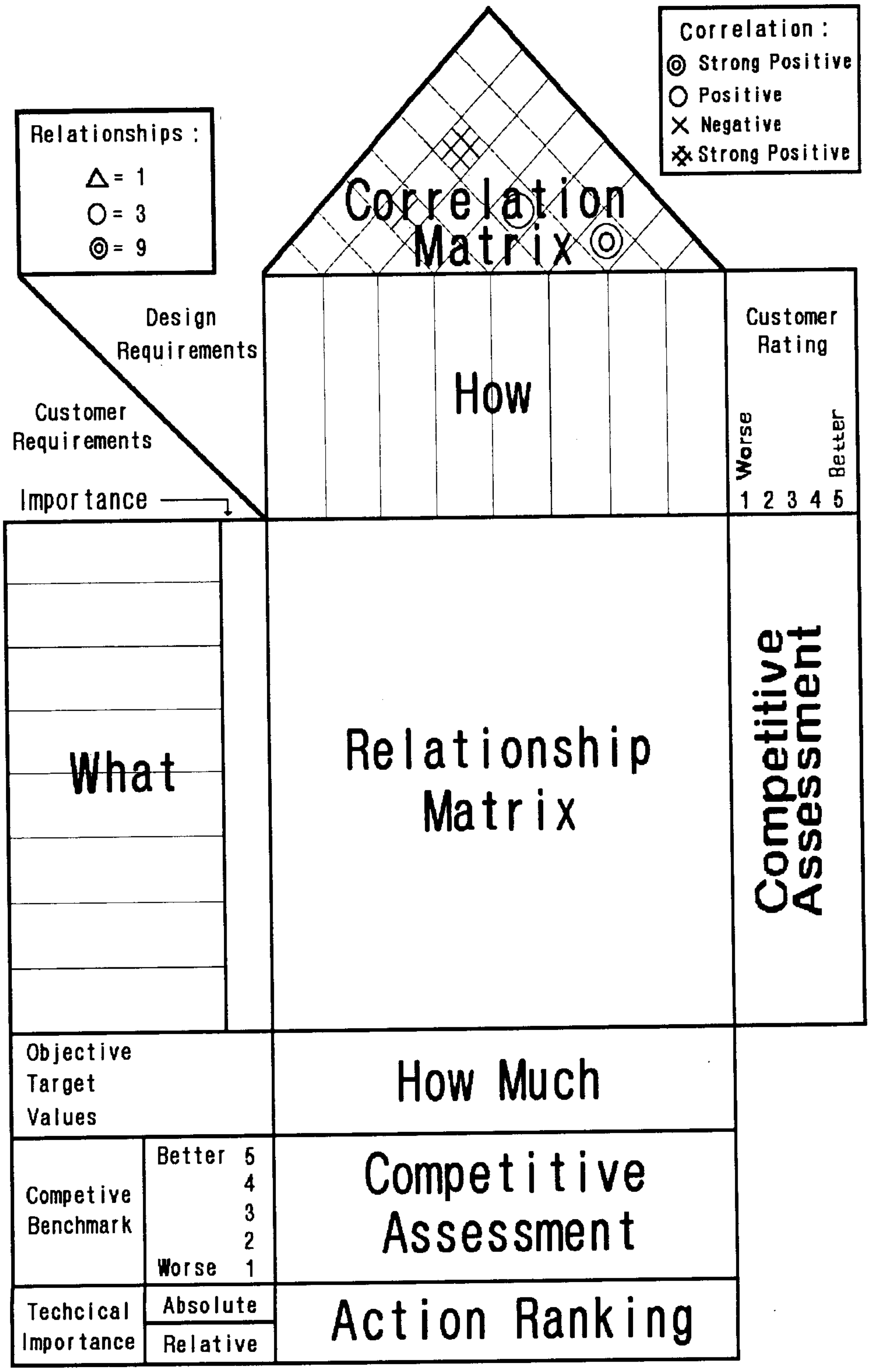

Fig. 2. The QFD matrix that can be used for all types of quality evaluation.

manufacturer for warranty costs; or loss of the customer from repaire costs. The value of K is a composite cost made up of all internal costs as well as warranty and field costs. Central to this loss function concept is the idea of keeping variability to a minimum by making products as close to set target value as possible. Taguchi design of experiment, called the Taguchi method after his name, is for this purpose. This is a simplified version of the conventional design of experiment not to remove the cause of variability but to eliminate or alleviate its effect by applying the concept of the noise-and-signal factors: the noise factors are the causes of variability such as humidity, temperature, dust, the deterioration of product due to uncontrollable variations in the raw materials; the signal factors are parameters that designers can change arbitrarily. Because keeping tolerances within narrow limits is expensive, this method schemes minimizing the influence of the noise factors by a parameter design. The QLF was a conceptual breakthrough, which provided a theoretical basis justifying the endless improvement of product quality.

The seven quality management tools are the management-level methodologies, while the seven quality control tools serve the control-level problem-solving. The seven quality management tools are comprised of affinity diagram; relationship diagram; tree diagram; matrix chart; matrix data analysis chart; arrow diagram; process decision program chart. Unlike the seven quality control tools, most of these are featured to respond to the situations where the necessary date are obtained in linguistic forms.

An affinity diagram is used for a grouping of large unorganized data, and a relationship diagram is for analyzing the cause-and-effect relationship among events that have influence upon decisions under consideration. These methods are concerned with the documentation in the planning phase of overall quality management cycle. A tree diagram deploys the tasks and means needed to solve a quality problem. A matrix chart facilitates clarifying problems and relationships of a subject of concern by utilizing a matrix-type array of data. A matrix data analysis chart, the only statistical method of this tool kit, is a multivariate analysis whose primary purpose is data reduction and summarization. These tools are used in the intermediate planning phase of the planning cycle. An arrow diagram, a simpler form of critical path method, is used for an optimum scheduling of a quality planning. A process decision program chart is a device to anticipate all the causes that can happen to make a planned result unobtainable. In this regard, this chart is a kind of contingency planning scheme. These tools are all concerned with the detailed planning phase after which an actual implementation takes place.

QFD, QLF, and the seven quality management tools, except the arrow diagram, share something in common: creativity and innovation-oriented methodologies; purports a continuous improvement of quality; customer-oriented; calls for all employee participation; applied vigorously in Japanese firms. Considering these, it seems that the features of Japanses Company-Wide-Quality-Control are well reflected by these methodologies. As a matter of fact, these tools can hardly be utilized in full swing without involvement of Quality Control Circles a focal ingredient of Japanese CWQC.

4. Manufacturing strategy point of view

Manufacturing had long been left out of a strategic concern under the misled notion that the main criterion for evaluating manufacturing performance is efficiency and cost, the management of factories is an engineer's task filled with day-to-day routines of engineering and technical matters, and has nothing to do with the formulation of a corporate strategy. Recently, however, there have been an increasing application of no few fairly new approaches that make manufacturing more customer-oriented and strategic: focused factory concept, just-in-time manufacturing, and flexible manufacturing systems to name a few. These approaches provide manufacturing managers with many strategic alternatives to choose from: low cost, high quality, short-cycle times, high flexibility, a rapid introduction of new product, etc. The focused factory was introduced early 1970s, but didn't get much attention until recent past when the customer needs placed on a product became diversified beyond the level that a conventional factory could handle with reasonable efficiency. The focused factory is an answer to solving this diversifying needs. According to Skinner, a factory that focuses on a narrow product mix for a particular customer need or market niche will outperform the conventional, nonfocused factory, which attempts manufacturing of a wide-range of product mix. Because its equipment and supporting systems including the factory infrastructures can concentrate on a limited task for a particular customer group, its costs are likely to be lower than those incurred in a conventional factory. Furthermore, a focused factory can be used as a competitive weapon because its entire effort is focused to achieve the particular manufacturing task designed in line with the firm's competitive strategy[Skinner, 1974]. Essentially, in a focused factory the total manufacturing job is dividing up into a number of focused units each of which is responsible for a limited set of activities and objectives, instead of putting all manufacturing activities for all products and models under the roof of a single large factory[Hayes, et al. 1988]. The focusing also fosters quality, and shortens cycle times.

The flexible manufacturing system is another strategic manufacturing technology. FMS is a group of numerical-controlled machines, robots, or other automated workstations, which are interconnected by materials handling equipment[Boer, et al. 1989]. These interconnected units can be grouped into cells, which handle a variety of fabricated parts automatically in the order programmed in the computer. Capable of being easily switched from producing one product to producing the next in random order without change-over delay, the systems make a lotless production possible. It means that manufacturing managers can make quicker responses to the changing demands in market places. This flexible manufacturing system also has an important meaning to product quality: it achieves a higher level of quality assurance because the robot, which is normally an integral part of the system, is capable of inspecting the total number of product fabricated.

Just-In-Time is a production control system designed to run manufacturing facilities in such a way as to maintain inventory at the lowest possible level. JIT is also a management philosophy that strives to eliminate waste in terms of both material and time through a continuous improvement of productivity. JIT is a pull system that pulls a work-in-process through production processes by downstream demand, and that pulls raw materials from suppliers just when needed[Vobee, et al. 1993]. This pull system contrasts sharply with a traditional push system, in which a batch of materials flows through the system, often creating excess stockpiles wherever possible. By using this pull system, JIT achieves a maximum prevention of defective parts passed on the next worker on the same production line. Producing the right quantity at the right time also reduces inventories and waste, fostering the economical use of working space. The reduced inventories in turn reduce cycle times. Not only material inventory but also finished goods inventory is reduced, because products are made only to meet sales demand.[Yasuhiro, 1983] The successful implementation of JIT system requires on-time delivery of defect-free materials or parts, skilled operators who are capable of handling problems that may arise during production, and close cooperation. All these demand a full commitment of production employees involved. These characteristics of JIT make possible the quality management more strategic by bringing about higher quality, higher flexibility, shorter cycle times, etc. As a matter of fact, past several years have witnessed the shifting nature of customer wants from the conventional criteria such as cost and quality to delivery speed and delivery reliability. For example, in a recent survey, delivery speed and delivery reliability ranked higher as an order-winning creterion than conformance quality[Hill, 1994].

5. Discussion

The quality definitions examined seem to fall basically in the same category. Only subtle difference is found between Juran's and Crosby's but is not considered as significant as to determine that TQC and TQM stand on different bases of definition of quality. It is true that Juran's "Fitness for use" seems more user-oriented than Crosby's "Conformance to requirements," but it might be no more than the difference of wordy expression.

In the technological aspect, however, TQC and TQM tend not to share all the tools so far developed to the same degree: TQC relies heavily on the seven quality control tools, comprised of mostly statistical methods that measures products quality and manufacturing processes. TQC, however, is different from SQC in the coverage of control functions. In an attempt to achieve quality at the source, rather than taking defects off the production line, control is done by virtually all organizational areas: marketing, engineering, manufacturing engineering, manufacturing operations, installation, purchasing, service, venders, etc.[Cartin, et, al. 1993]. In this regard, TQC is a more thorough control system than SQC, but the responsibility for quality still rests with the functional specialists.

TQM, on the other hand, commands both of the seven quality control tools and the seven quality management tools[Cartin, et, al. 1993]. Notice that QFD and some of the quality management tools are deeply concerned with measuring customer needs not with measuring products quality to decide whether they conform the design specifications.

The focused factory, JIT, and FMS contribute greatly to the enhancement of product quality, and also give quality managers strategic alternatives such as short cycle times, a rapid introduction of new products, high flexibility, etc., to better serve an aimed market niche or a customer group.

According to Lumsdain[Lumsdain, 1990], quality management has been developed through the seven stages of development as following:

<u>Stages of TQC</u>

Stage 1. Efforts concentrate on inspection and problem analysis: product-oriented.
Stage 2. Efforts concentrate on quality assurance on production: process oriented.
Stage 3. All departments are involved in quality assurance: systems-oriented.

<u>Stages of Japanese Company-Wide-Quality-Control</u>

Stage 4. All employees are involved and continuously trained: people-oriented.
Stage 5. Optimized product and process designs result in robust products: society-oriented.
Stage 6. The quality loss function links quality to cost: cost-oriented.
Stage 7. QFD defines the voice of the customer in product terms: customer-oriented.

The first three stages generally characterize TQC as an in-company system of quality control activities of inspection and quality assurance, with the involvement of all functional departments. The next four stages, which are characterized by CWQC strongly imply, beyond the control of the quality of products or services, the management of the quality of management, the quality of work performed, the quality of employees, and the quality of the work environment.

Galvin[Galvin, 1993] tried to classify the evolution of quality movement into three steps, by utilizing the three criteria: functional focus, major driver, and major tools. Fig. 3 shows his classification.

	Functional focus	Major driver	Major tools
1. Quality control	Separate QC function	Management	Inspection
2. Quality assurance	Transaction with customer	Customer	SPC, training QC circles
3. Total Quality Management	All functions and processes	Management, employees, and customers	Statistical tools, behavioral tools, employee participation,. and integrated managemenent systems

Fig. 3. The evolution of quality movement

The Galvin's classification finds that TQM differs from Quality Control and Quality Assurance. Galvin also claims that TQM has been greatly influenced in the process of its formulation by the Japanese CWQC. Galvin mentions:

> "Over the course of 50 years, from America to Japan and back again, these management methods of imbedding quality into the entire corporation have evolved to become known as Total Quality Management."

The analyses made under the methodological perspective and the discussions presented so far are thought to be congruent to the Galvin's classification and claim.

Another question is whether TQM means management itself. It is necessary to make a brief review of the definition of management. "Management is the process of achieving organizational goals through planning, organizing, leading, and controlling the human, physical, financial, and information resources of the organization in an effective and efficient manner." At a glance, one can realize that management stands on a very broad conceptual basis. To achieve its goals, management relies on the vast array of technological systems: mathematics, operations research, accounting, economic theories, psychometrics, behavioral sciences, etc. TQM tools are to achieve only a firms quality goal which is a part of an overall management goal.

6. Concluding remarks

The analyses and discussions presented so far indicate that TQC and TQM are not synonyms. TQM involves SQC and TQC in quality definitions, methodologies, and purposes. TQC is broader than SQC in methodological stand point, but still remains in large part as a control-level activity. TQC centers around measuring and assuring a product quality through utilizing statistical tools. TQC differs from SQC in that it is carried out not only by quality control functions but by all the functions in an organization. However, it doesn't mean an all-people involvement.

TQM relies not only on control-level tools but also on planning-level ones. As seen in the methodological perspective, the seven quality management tools are mostly concerned with quality planning.

TQM is more people-oriented while TQC alone is more function-oriented. In TQM, the responsibility for quality rests on all employees rather than on design engineers and functional specialists. The quality control circle, one of the main ingredients of Japanese CWQC well reveals this feature. The workers on a JIT production line are not only manufacturing operators, but they are all inspectors as well.

TQM lays a stress on measuring customer needs in the first place, while TQC puts an emphasis on measuring the quality of products during or after making. QFD, a powerfull tool of TQM, is an excellent device of measuring customer needs.

TQM is a kind of strategic management systems. By utilizing the TQM tools, a decision-maker can anticipate the most important customer needs likely to be placed on a product of his concern so that he will be able to make a right choice of a manufacturing strategy fit for the identified needs.

TQM is not synonymous with management. Like production, finance, accounting, marketing, personnel, legal, and others, TQM is a subsystem of management. TQM, however, becomes one of the most dominant strategic subsystems of management, along with the increasing importance of responding to customer needs, for satisfying them is regarded as the key to winning the battle of the quality war.

References

[1] Feigenbaum, A.V. Total Quality Control. 3rd ed. McGraw-Hill, New York, 1986.
[2] Juran, J.M. Quality Control Handbook. 3rd ed. McGraw-Hill, New York, 1974, pp. 2-2-2-11
[3] Crosby, P.B. Quality Is Free. New American Library, New York, 1979, pp. 14-15.
[4] Seghezzi, H.D. "What is Quality: Conformance With Requirements or Fitness for the Intended Use." EOQC Journal 4 (1981):3.
[5] QS - Norm Draft of Swiss Standard Association, 1981.
[6] EOQC, "Glossary of Terms Used in Quality Control," 5th ed. EOQC, 1981.
[7] ANSI/ASQC Standard, "Quality System Terminology," A3 - 1978, Prepared jointly by the American National Standards Institute and the American Society for Quality Control.
[8] Cartin, T.J. Principles and Practices of TQM. ASQC Quality Press, Milwaukee, Wisconsin, 1993.
[9] Taguchi, G. Introduction to Quality Engineering. Asian Productivity Org., 1986.
[10] Galvin, R.W. The Corporate Guide to the Malcolm Baldrige National Quality Award. ASQC Quality Press. Milwaukee, Wisconsin, 1993.
[11] Boer, et al. "FMS Implementation Management: Premise and Performance," International Journal of Operations & Production Management. Vol 10, No 1, 1989, pp. 5-20.
[12] Vovee, et al. Management. McGraw-Hill. New York, 1993.
[13] Skinner, W. "The Focused Factory," Harvard Business Review, May-June 1974, pp. 113-21.
[14] Hayes, et al. Dynamic Manufacturing. Free Press, New York, 1988.
[15] Hill, T Manufacturing Strategy: Text and Cases. Irwin, Boston, Massachusetts, 1994.
[16] Lumsdane, et al. Creative Problem Solving, McGraw-Hill, New York, 1990
[17] Toshiyuki, M. Deployment of Strategic Management, JUSE, Tokyo, 1985.