CONSTRUCTION QUALITY MANAGEMENT

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1 INTRODUCTION TO CONSTRUCTION QUALITY MANAGEMENT

Quality is widely accepted as one of the key factors for companies to be successful in the global market. Quality management has been an important issue for many years in various disciplines. The implementation of effective quality management has been witnessed and documented in the manufacturing industry, which set up a paradigm for other disciplines such as the design and construction industry. In the past few years, things have changed in the construction sector. It has opened its doors by welcoming policies that would improve construction process and lead to successful business strategies. Effective quality management, especially **total quality management** (TQM), has been recognized as an enabler for performance improvement in the construction industry.

1.1 An Introduction to Quality

Quality can be defined as a state that meets the legal, aesthetic and functional requirement of a product or project by customers. Requirements may be simple or complex, or they may be stated in terms of the result required or as a detailed description of what is to be done. Metrology, specifications, inspection all go back many centuries before the Christian era. Following the Second World War, two major forces emerged that have had a profound

impact on quality: (1) the Japanese revolution in quality; and (2) the prominence of product quality in the public mind. During the twentieth century, a significant body of knowledge on achieving superior quality emerged, advanced by Juran, Deming, Feigenbaum, Crosby and Ishikawa. Here are some examples of defining quality.

> "Providing customers with products and services that consistently meet their needs and expectations" — Boeing
>
> "Meeting the customer's need the first time and every time" — General Services Administration, US Government
>
> "Performance to the standard expected by the customer" — FEDEX
>
> "Doing the right thing right the first time, always striving for improvement, and always satisfying the customer" — US Department of Defense

From the above examples, quality has the following common characteristics:

1. It involves meeting or exceeding customer expectations.
2. It applies to products, services, people, processes, and environments.
3. It is an ever-changing state (i.e., what is considered quality today may not be good enough to be considered quality tomorrow).

Quality is a dynamic state associated with products, services, people, processes and environments that meets or exceeds expectations. Quality is always related to customer satisfaction/loyalty and the fitness of use is designed for end customers. Figure 1.1 gives a detailed look into the customer structure of a manufacturing company.

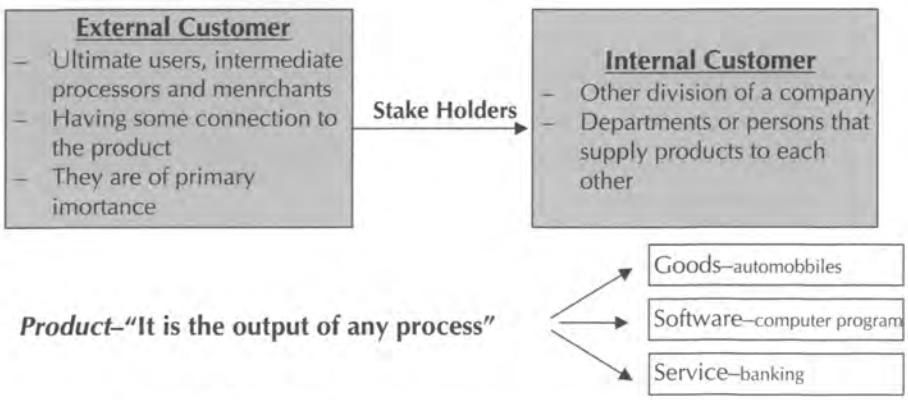

Figure 1.1 Customer structure of a manufacturing company

1.2 The Relationship of Quality with Productivity, Costs, Cycle Time and Value

1.2.1 Quality and Productivity

- Productivity = $\frac{\text{Saleable output}}{\text{Resources used}}$
- Improvement in quality directly results in an increase in productivity.

1.2.2 Quality and Costs

- As the quality of design increases, cost increases.
- As the quality of conformance increases, cost decreases.

1.2.3 Quality and Cycle Time

- The cycle time to complete the activities is the key parameter.
- Quality improvement efforts will reduce cycle time.

1.2.4 Quality and Value

- Value = Quality/ Price
- Organizations must evaluate the value they provide, relative to the competition.

1.3 Quality Management

Quality management is the process of identifying and administering the activities needed to achieve the quality objectives of an organization.

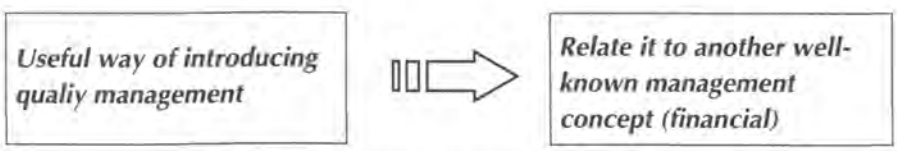

Figure 1.2 Diagram of quality management

Quality management is defined as (BS EN ISO 8402):

> "All activities of the overall management function that determine the quality policy, objectives and responsibilities, and implement

them by means such as quality planning, quality control, quality assurance, and quality improvement within the quality system."

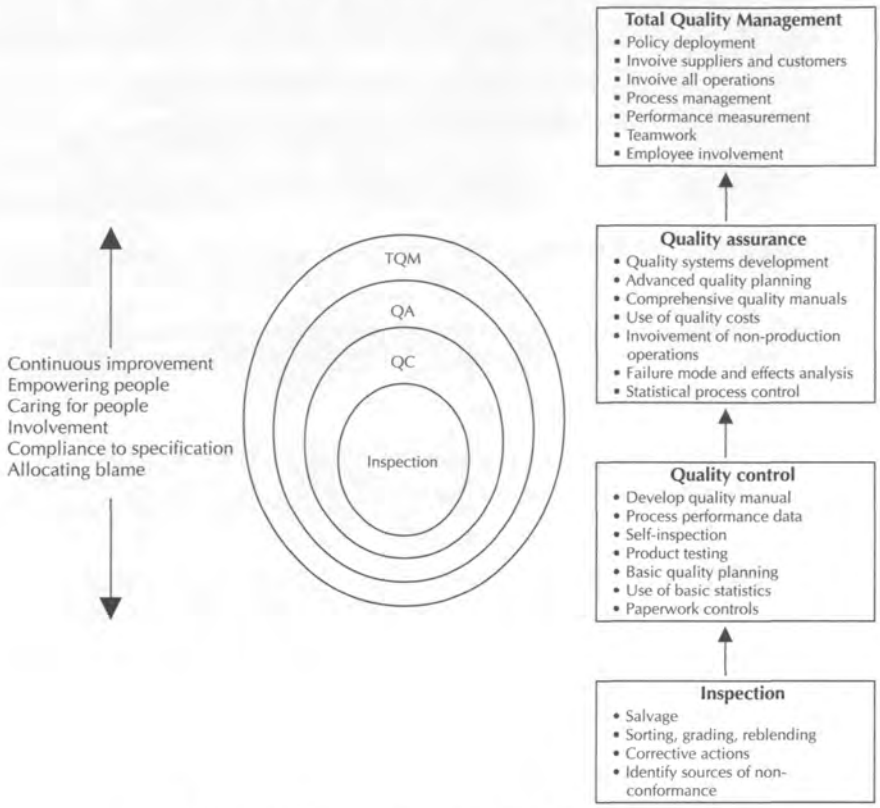

Figure 1.3 The four stages of quality management

The four stages of quality management are shown in the Figure 1.3. Inspection and QC are retrospective; they operate in a detection mode, aiming to find problems that *have occurred* (fire fighting). QA and TQM aim to reduce and ultimately to avoid problems occurring; they can be used to bring about improvement (fire prevention).

1.4 Terminology

Some important terms for quality management are as follows:

Quality

ISO 8402 defines quality as the degree of excellence in a competitive sense, such as reliability, serviceability, maintainability or even individual characteristics.

Quality Control

Both ANSI and ISO define quality control as the operational technique and activity to control and measure the characteristics of a material, structure, component, or system that are used to fulfill requirements for quality.

Quality Systems

Quality systems refer to the organizational structure, procedures, processes and resources needed to implement quality management.

Quality Assurance

Quality assurance is the implementation of planned and systematic activities within quality systems to demonstrate and provide adequate confidence that an entity will fulfill requirements for quality.

Quality Management

Quality management refers to all activities of overall management functions, especially top management leadership, that determine quality policy objectives and responsibilities for all members of the organization.

Total Quality Management

Total quality management is the management approach of an organization, which is based on the participation of its members, concentrates on quality and aims at achieving long-term success through satisfaction and benefits to all members of the organization and society (ISO 8402 and Griffin 1990).

Sometimes, "quality systems" and "quality management" together are described as "quality management systems'. These terms will be used in the rest of this chapter and in the other chapters of this book.

1.5 Quality Evolution

There are five stages in the evolution of quality control, as defined by Rounds and Chi (1984) and Feigenbuam (1991).

- Craftsman quality control was inherent in manufacturing up to the end of the nineteenth century. At that time, a very small number of craftsmen were responsible for the manufacturing of a complete product and each craftsman exclusively controlled the quality of his work.
- Foreman quality control occurred during the industrial revolution when large-scale modern factory concept developed. During this stage, many craftsmen performing similar tasks were grouped together and supervised by a foreman, who then assumed responsibility for the quality of their work.
- Inspection quality control evolved during the First World War when the manufacturing systems became more complex. Because a large number of craftsmen reported to a production foreman, full-time inspectors were required. This era peaked in large organizations in the 1920s and 1930s.
- Statistical quality control flourished during the Second World War when tremendous mass production was necessary. In effect, this step was a refinement of the inspection step and resulted in making the large inspection organizations more efficient. Inspectors were provided with statistical tools such as sampling and control charts. W.A. Shewhart developed a statistical chart for the control of product variables in 1924, marking the beginning of statistical quality control. Later in the same decade, H.F. Hodge and H.G. Roming developed the concept of acceptance sampling as a substitute for 100% inspection; this was considered the most significant contribution of statistical quality control.
- Total quality control evolves in the early 1960s in a four-phase process. A dramatic increase in user quality requirements resulted in increasing customer demand for higher-quality products, forcing the manufacturer to recognize the inadequacy of existing in-plant quality practices and techniques. All these contributed to excessive quality cost, due to such items as inspection, testing, laboratory checks, scrapping and reworking imperfect products, and customer dissatisfaction. These problems highlighted the dual quality challenge: providing significant improvement in the quality of products and practices while, at the same

time, effecting substantial reductions in the overall cost of maintaining quality. Statistical quality control could never meet the challenge; thus, a totally new concept was developed based upon the principle that in order to provide genuine effectiveness, control must start with the design of the product and end only when the product has been placed in the hands of a customer who remains satisfied (Feigenbuam 1991).

1.6 Pioneers of the Total Quality Movement

Total quality is not just one individual concept. It is a number of related concepts pulled together to create a comprehensive approach to doing business (Goetsch and Davis 2003). The major contributors to this concept are W. Edwards Deming, Joseph M. Juran, Philip B. Crosby and Kaoru Ishikawa.

1.6.1 Deming

W. Edwards Deming of the United States is considered the father of the quality movement. He is widely known for the Deming Cycle, his Fourteen Points, and the Seven Deadly Diseases.

The Deming Cycle

The basic premise of Deming's cycle covers concepts that apply to all organizations (eCommerce-Now 2001):

1. Plan: How are you going to look at the problem?
2. Do: Carry out the research.
3. Check: Review the results, and see if it achieves what you were aiming to do; if not, go back to step one.
4. Act: Decide that something needs to be altered in your work place, and make a decision to bring about an improvement.

Deming's "plan-do-check-act" cycle will be further discussed in Chapter 7 in detail.

Deming's Fourteen Points

The 14 points are a basis for the transformation of (American) industry. Adoption and action on the 14 points are a signal that management intends to stay in business and aim to protect investors and jobs (Deming 1982, 1986).

1. Create constancy of purpose toward improvement of product and service, with the aim to become competitive and to stay in business, and to provide jobs.
2. Adopt the new philosophy. In a new economic age, management must rise to the challenge, learn their responsibilities, and take on leadership for change.
3. Cease dependence on inspection to achieve quality. Eliminate the need for inspection on a mass basis by building quality into the product in the first place.
4. End the practice of awarding business on the basis of price tag. Instead, minimize total cost. Move towards a single supplier for any one item, on a long-term relationship of loyalty and trust.
5. Improve constantly and forever the system of production and service, to improve quality and productivity, and thus constantly decrease costs.
6. Institute training on the job.
7. Institute leadership. The aim of supervision should be to help people and machines and gadgets to do a better job. Supervision of management is in need of an overhaul, as well as supervision of production workers.
8. Drive out fear, so that everyone may work effectively for the company.
9. Break down barriers between departments. People in research, design, sales, and production must work as a team, to foresee problems of production and problems that may be encountered when using the product or service.
10. Eliminate slogans, exhortations, and targets for the workforce asking for zero defects and new levels of productivity. Such exhortations only create adversarial relationships, as the bulk of the causes of low quality and low productivity belong to the system and thus lie beyond the power of the workforce.
11. a. Eliminate work standards (quotas) on the factory floor. Substitute with leadership.
    b. Eliminate management by objective. Eliminate management by numbers, numerical goals. Substitute with leadership.
12. Remove barriers that rob the hourly paid worker of his right to pride in workmanship.
13. Institute a vigorous programme of education and self-improvement.

14. Put everybody in the company to work to accomplish the transformation. The transformation is everybody's job.

Deming's Seven Deadly Diseases

1. Lack of constancy of purpose
2. Emphasis on short-term profits
3. Evaluation by performance, merit rating, or annual review of performance
4. Mobility of management
5. Running a company on visible figures alone
6. Excessive medical costs
7. Excessive costs of warranty, fueled by lawyers that work on contingency fee

1.6.2 Pareto

In 1906, Italian economist Vilfredo Pareto created a mathematical formula to describe the unequal distribution of wealth in his country, observing that 20% of the people owned 80% of the wealth. The 80/20 Rule means that in anything a few (20%) are vital and many (80%) are trivial. In Pareto's case it meant 20% of the people owned 80% of the wealth. In Juran's initial work he identified 20% of the defects causing 80% of the problems. Project managers know that 20% of the work (the first 10%and the last 10%) consumes 80% of the total time and resources. The 80/20 Rule can be applied to almost anything, from the science of management to the physical world.

The value of the Pareto Principle is that it reminds a manager to focus on the 20% that matters. Of all the things done during the day, only 20% really matters. That 20% produces 80% of the total results. Identify and focus on those things. If something in the schedule has to slip, if something is not going to get done, make sure it is not part of that 20% (Reh 2003).

1.6.3 Crosby's Zero Defects

"Zero defects" is a performance standard introduced by Philip H. Crosby in 1979. The Crosby process can help an organization by providing a quality management culture. Lean and Six Sigma can be effective "tools", but a tool becomes more beneficial when it is put to work regularly. To do that, a quality "culture" is needed to encourage (or insist) that everyone participate in this important process (Philip Crosby Ass. 2002).

1.6.4 Ishikawa

The cause and effect diagram is the brainchild of Kaoru Ishikawa, who pioneered quality management processes in the Kawasaki shipyards, and in the process, became one of the founding fathers of modern management. The cause and effect diagram is used to explore all the potential or real causes (or inputs) that result in a single effect (or output). Causes are arranged according to their level of importance or detail, resulting in a depiction of relationships and hierarchy of events. This can help the search for root causes, identify areas where there may be problems, and compare the relative importance of different causes.

1.6.5 Juran

Joseph Juran's "quality trilogy" is made up three components: (1) quality planning, (2) quality control, and (3) quality improvement. This trilogy of quality process leads to successful framework for achieving quality objectives. The processes must occur in an environment of inspirational leadership and the practices must be strongly supportive of quality. A brief description of the Juran's quality trilogy is given below.

1. Quality Planning
    a. Determine who the customers are.
    b. Identify customers' needs.
    c. Develop products with features that respond to customer needs.
    d. Develop systems and processes that allow the organization to produce these features.
    e. Deploy the plans to operational levels.

2. Quality Control
    a. Assess actual quality performance.
    b. Compare performance with goals.
    c. Act on differences between performance and goals.

3. Quality Improvement
    a. Develop the infrastructure necessary to make annual quality improvements.
    b. Identify specific areas in need of improvement, and implement improvement projects.
    c. Establish a project team with responsibility for completing each improvement project.

d. Provide teams with what they need to be able to diagnose problems to determine root causes, develop situations, and establish control that will maintain gains made.

1.7 Quality Control (QC) and Quality Assurance (QA)

Quality control (QC) is the specific implementation of a quality assurance (QA) programme and related activities. Effective QC reduces the possibility of changes, mistakes and omissions, which in turn result in fewer conflicts and disputes.

Quality assurance (QA) is a programme covering activities necessary to provide quality in the work to meet the product/project requirements. QA involves establishing project related policies, procedures, standards, training, guidelines, and system necessary to produce quality. QA provides protection against quality problems through early warnings of trouble ahead. Such early warnings play an important role in the prevention of both internal and external problems.

In practice, the two terms quality assurance and quality control are frequently used interchangeably, which is undesirable. Since quality control is a part of quality assurance, maintaining a clear distinction between then is difficult but important. Quality assurance is all the planned and systematic actions necessary to provide adequate confidence that a structure, system or component will perform satisfactorily and conform to project requirements. On the other hand, quality control is a set of specific procedures involved in the quality assurance process. These procedures include planning, coordinating, developing, checking, reviewing, and scheduling the work. The quality control function is closest to the product in that various techniques and activities are used to monitor the process and to pursue the elimination of sources that lead to unsatisfactory quality performance. Most design-related quality assurance and quality control activities are covered by a design organization's standard office procedures.

1.8 Total Quality Management (TQM)

The primary purpose of TQM is to achieve excellence in customer satisfaction through continuous improvements of products and processes by the total involvement and dedication of each individual who is in any way, a part of

that product/process (Ahmed 1993). The principles of TQM create the foundation for developing an organization's system for planning, controlling, and improving quality.

TQM is a structured approach to improvement. If correctly applied, it will assist a construction company in improving its performance. It involves a strong commitment to two guiding principles: customer satisfaction and continuous improvement. In a study of customer satisfaction factors for clients of the transportation, food, chemical and paper, utilities and other miscellaneous industries, it was found that timeliness, cost, quality, client orientation, communication skills, and response to complaints were most significant (Ahmed and Kangari 1995). Another study suggests that TQM methodology like quality function deployment (QFD), provide a structured framework for continuous improvement and customer satisfaction (Ahmed and Kangari 1996).

TQM philosophy will be further discussed in Chapter 7.

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12

DEVELOPING A QUALITY CULTURE AS THE WAY FORWARD

One of the main emphases of the quality management system is continual improvement of an organization, in particular, the effectiveness of its processes and its products. In order to identify areas for improvement, quantitative measurements are necessary. The tool, quality costing — particularly the construction process cost model (CPCM) discussed in Chapters 10 and 11 — is considered as one of the quality improvement techniques which can be applied to the construction industry. However, having a correct tool to control and measure continual quality improvement is only the first step towards a successful implementation of a quality management programme. There are many key factors without which a quality management system will fail. Among them, continual commitment from top management and employees is described by many researchers as the most important factor (Burati Jr. and Oswald 1993; Carlsson and Carlsson 1996; Low and Omar 1997; Mo and Chan 1997; Tan 1997; Arditi and Gunaydin 1998; Laszlo 1999, Ahmed *et al.* 2005). This can be understood because though an organization has the best quality plan prepared by consultants, the success still depends on how the organization (top management and employees) implements it. The collective attitudes and beliefs of employees towards quality are commonly described as the quality culture of an organization. Therefore, the quality management system and its principles must build on a good quality culture.

12.1 Quality Culture

Quality culture is defined as the pattern of human habits, beliefs, and behavior concerning quality (Gryna 2001). An organization with a good "quality culture" is the one having positive and clear habits, beliefs, and behavior concerning quality. These habits, beliefs, and behavior will manifest themselves in the actions of top management and employees. Therefore, creating a good quality culture that supports quality management is vital in the implementation and maintenance of quality management systems. Otherwise, as quoted from Cortada and Woods (1995), "the use of quality management techniques will be mechanical and not likely to deliver the long-term results for customer satisfaction, more efficient processes, lower costs, growth, and profitability that it promises".

Before developing a good quality culture in the construction industry, a brief review of the existing quality culture is necessary. Due to the complexity of construction projects, the development of the existing quality culture in the construction industry can be described as the result of certain inherent characteristics in construction projects. Ritz (1994) describes four common characteristics of construction projects as follows:

1. Each project is unique and not repetitious.
2. A project works against schedules and budgets to produce a specific result.
3. The construction team cuts across many organizational and functional lines that involve virtually every department in the company.
4. Projects come in various shapes, sizes, and complexities.

Each characteristic above shapes the quality culture of the construction industry to a certain extent. As each project is unique to the parties involved, most people will not be staying in one project for too long a period. This high mobilization of construction staff will result in shortsightedness and a lack of long-term commitment of staff towards quality in general. Moreover, the bonding between contractor and subcontractors and among subcontractors is usually weak due to the relatively short duration of construction projects. Therefore, it is rather difficult to create a teamwork environment on site. Construction projects usually have a prescribed scope, schedule and budget to produce a quality "product". Balancing the triangular relation between the scope, schedule and budget of a project is always a challenge faced by management. Though quality is generally viewed as an integral part of scope, budget and schedule, its importance can easily be

neglected due to the ever changing of scope from clients and tight budget and schedule resulted from the highly competitive construction market. Due to the complexity of construction projects, the parties involved, subcontractors in particular, in a particular project is usually numerous. In Hong Kong, it is not uncommon for a construction project to have more than 50 subcontractors on site, with more than 80% of work in terms of contract sum to be subcontracted (Tang *et al.* 2003). It is still debatable whether multi-layer subcontracting is beneficial or adverse to the construction industry. In the context of quality management, however, its adverse effects are obvious. First of all, it is natural for an individual party involved to put its own interest before others. As a result of this, there will be a lack of communication, trust and harmony among different parties and the atmosphere is usually confrontational and adversarial. Moreover, multi-layer subcontracting reduces the profit margin of each party and therefore leaving no extra resources for the implementation of any quality initiatives. Meeting the minimum quality requirement from customers becomes an accepted culture in the industry in general because of the financial constraint. The complexity of construction projects also shapes the quality culture of the construction industry. In a typical construction site, it is common to have many construction processes and activities going on simultaneously. It is essential to monitor and control these processes besides the final products because the cost of remedial work of nonconforming products is usually very substantial. Unfortunately, it is a common practice to inspect only the final product at different stages of the construction due to resource constraint.

Broadly speaking, the above discussion has pointed out that the "natural" quality culture existed in the construction industry has been in constant conflict with the key features of quality management systems advocated by researchers. Chase and Federle (1992), Abdul-Rahman (1996) and Tsiotras and Gotzamani (1996) also indicated that one of the main reasons for the failure of any quality management initiatives was the lack of long-term commitment to quality from the top management. Moreover, numerous surveys and publications (Low and Yeo 1997; Ahmed and Aoieong 1998; Moatazed-Keivani *et al.* 1999; Kumaraswamy and Dissanayaka 2000) have concluded that "fulfilling clients' requirements", and not "improving quality", was considered by most contractors as one of the main motivations for undertaking any quality management initiatives. As described by Kam and Tang (1998), the Hong Kong contractors were forced, by their major clients, Hong Kong Works Bureau and Hong Kong Housing Authority, to develop their quality management systems based on the ISO 9000 standard. The ISO certification so obtained was also considered as a "work permit" to bid

government projects. As a result of it, the driving force, or commitment, from the top management to review, maintain and improve the quality management system will soon diminish once the certification process is completed. Needless to say, the lack of incentive to do better will definitely be reflected from the employees' daily works. Once again, the findings reinstate the fact that the successful implementation of a quality system lies on how organizations implement it and not the system itself.

12.2 Quality Culture Audit

In order to create an environment which will facilitate the implementation of quality management systems, changes in quality culture are necessary. As a matter of fact, cultural change, whether small or drastic, is a prerequisite to the successful implementation of any quality programme. Since different organizations have different cultural pattern, it is essential for the top management to conduct a cultural audit for various levels of management and work force so that the differences between the existing and the desired quality culture can be properly assessed.

The cultural audit can be conducted through carefully designed questionnaire surveys on quality and interviews with top management and employees. The content of such surveys and interviews should include the evaluation of the values and attitudes of employees towards quality. In designing the questionnaire, the following characteristics of a good quality culture can be used as a benchmark (Goetsch and Davis 2000):

1. Open, continual communication
2. Mutually supportive internal partnerships
3. Teamwork approach to problems and processes
4. Obsession with continual improvement
5. Broad-based employee involvement and empowerment
6. Sincere desire for customer input and feedback

The cultural audit is an important step towards cultural change particularly in the construction industry due to the fact that construction worker's perceptions of quality is generally low. An example of an assessment worksheet for collecting information is also provided by Goetsch and Davis (2000). With the results obtained from the cultural audit as baseline, top management can properly identify the areas for changes, access the resources required and apply specific measures to cultural change which will be beneficial to the organization.

12.3 A Change of Culture

The successful implementation of quality management systems requires the creation of a quality culture. According to Cortada and Woods (1995), the five values below must be presented by the top management to create a quality culture:

1. A focus on customer satisfaction
2. A focus on processes and their continual improvement
3. A focus on teamwork and cooperation
4. A focus on openness and sharing of information
5. A focus on the use of scientifically derived data for making decisions

Similar views were shared by Laszlo (1999) and Ngowi (2000). As a matter of fact, these values are very much similar to the quality management principles on which ISO 9000 was based. When applying these principles, however, top management should pay more attention to the human aspects (software) rather than just the methodologies (hardware). Creating an environment for good quality culture and developing down-to-earth practices in tune with these principles are as important as applying the principles. Tam *et al.* (2000) also shared the view that culture related factors are the most important ones affecting construction quality. Writing in the context of the construction industry, the following quality culture must be developed before the industry can reap the benefits resulted from the implementation of quality management systems.

1. In the construction industry, users of the final constructed work are usually considered as customers. For a typical construction project, there may be hundreds of processes involved from conceptual design phase to project completion. Strictly speaking, each process owner is the "customer" of the owner(s) of the preceding process(es) because process owners are internal customers within the quality management system. If each process owner satisfies the owner(s) of the succeeding process (es) (internal customer(s)), the ultimate user (external customer) will be satisfied. Major parties involved in the design and construction of a project include engineers, project managers, main contractor, subcontractors and suppliers. In addition to completing their individual assigned work, developing a culture of satisfying their internal customers is the first step towards total customer satisfaction. This is important particularly for the subcontractors of a construction project. Generally speaking, the main contractor is the customer of each subcontractor

because of the contractual relationship. However, the culture of satisfying their internal customers is usually ignored because there is no contractual relationship between subcontractors. A subcontractor (formwork, for example) does not treat his next subcontractor(s) (concrete and/or steel) as his customer(s). The quality of each subcontractor's work relies heavily on the main contractor's supervision and coordination because there is no incentive for subcontractors to perform better other than just satisfying the minimum requirements of the main contractor. The quality culture of satisfying internal customers should be promoted by the management so that a more operative and harmonious environment will be created among the process owners.

2. Process approach and continual improvement are two main themes of the year 2000 version of ISO 9000. A description of these themes was given in the previous chapters. To create a culture of process approach, the meaning of process must be understood not just at top management level but also at the field level by the crews. After knowing what processes meant, field crews should have a clear picture of their respective processes. Moreover, it is very important for employees to have a basic understanding of other related processes so that the interaction between processes and the impact of one on the others can be apprehended. For example, a formwork worker may not apprehend the reason why a missing bracing can have such an impact on both the cost and schedule of the concrete and/or steel subcontractor(s) who is the formwork subcontractor's customer(s). The task will be more carefully executed if he understands the process of placing formwork and its impact on the process of concreting.

   Improvements on processes can be made only if process owners have a thorough understanding of their respective processes. Developing a culture of process approach is therefore the first step towards the continual improvement of processes. Before the implementation of any programme to measure processes and to identify areas for process improvement, the top management must be able to convey the purposes of making process improvement and its benefits to all employees so that there will be incentive to do so. The main purpose of making continual improvement in processes is to increase their effectiveness and efficiency so as to allow the processes to become more competitive in the market. In construction, more communication between the main contractor and the subcontractors is encouraged so that a culture in seeking improvements together in the materials and methods used for a process

can be created. Any benefits resulted in such process improvement should be shared so that employees are motivated to continually improve their respective processes. Likewise, such culture should also be developed between the design team and the main contractor.

3. Since quality culture is described as the collective attitudes and beliefs of employees towards quality, it cannot be developed without a focus on teamwork and cooperation among the employees. In construction, adverse relationship often exists among the design team, the main contractor and the subcontractors due to the differences in their interests. As discussed in Chapter 11 on CPCM testing, subcontractors are always to blame for their non-conformities to specifications while main contractors are always to blame for their lack of overall coordination and control. The design teams, on the other hand, are always under the pressure to be more considerate and practical in their design. This culture of blame always exists and the situation may become worse especially when the project is behind schedule or is exceeding the budgeted cost. This is harmful to the spirit of the employees. In general, employees will work with a teamwork spirit and in a cooperative manner only when there are tangible benefits such as bonus sharing for early completion or rewards for excellent performance. Otherwise, it is rather difficult to develop a culture of teamwork and cooperation because of the tight schedule and budget of construction projects.

4. Organizations that promote openness to changes and sharing of information often exhibit good quality culture. Unfortunately, these characteristics are rarely found in the construction industry due to the high competitiveness among the different parties involved in construction projects. With the current information technology, it is not difficult for designers, main contractors and subcontractors to share information in various areas such as construction technology, standard detailing, material and equipment quotations and constructability. This sharing of information among the different parties may be able to reduce some duplicating works and therefore result in a lower total design and construction costs. In the manufacturing industry, this cultural change in information sharing between departments of an organization may be spontaneous because employees can anticipate the result of such change — cost reduction. In construction, however, project participants are often reluctant to share sensitive information because the savings resulted, if any, could end up in their competitors' pockets. Sharing experiences in non-conformances of works is even more difficult as it

will expose the incapacity of the parties involved and may result in higher cost of rework. Moreover, information should be shared not just among the project participants but also the researchers in the industry. Obtaining information from construction companies is very often difficult for researchers with no connections and as a result, many research projects have to be abandoned. In order to make advancement in various areas (such as quality, safety, environmental, tendering and scheduling), the industry must be more open in information sharing and be able to work in collaboration with researchers. Develop a good culture of information sharing between project participants is often difficult because of the conflicting interests existed. However, the concept of project partnering may provide a natural environment to develop such culture.

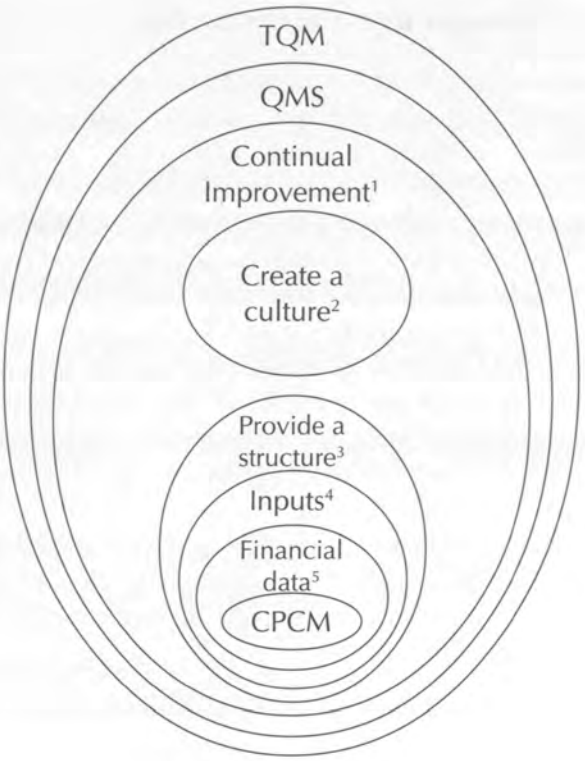
5. One of the most important elements in management is decision making. In order to minimize faults and ineffectiveness in the decision-making process, it is imperative that decisions made by different levels of management are based on the analysis of data and information. In general, with the help of many well-established methodologies and software available in the market, important decisions in construction (such as tendering, budgeting, scheduling and controlling) are commonly made based on scientifically derived data. However, the culture of collecting and analyzing non-conformance data has yet to be developed in the construction industry. In construction, the collection of non-conformance data is not common and is limited to certain construction processes for which inspections are performed. Such non-conformance data collection should be extended to cover other areas such as design and procurement. On the other hand, the collection of non-conformance data usually creates negative feedback from site workers because the data obtained from such is usually used only for finger-pointing and corrective actions. In order to develop a good quality culture of non-conformance data collection, the purpose must be made known to all staff so that a more positive view on it can be created. In general, the construction industry views the collection of non-conformance data as a fulfillment of the requirement of quality management systems and seldom uses the data so obtained for analysis. Top management staff should bear in mind that the collection of non-conformance data is the first step to continual improvement. Without the non-conformance data collection and analysis, the areas for improvement would be difficult to identify and therefore continual process improvement is difficult to achieve. Instead of just penalizing the staff for their wrongdoings after collecting non-conformance data, they should be educated and reminded that such data is beneficial to the organization as a whole.

12.4 Top Management Commitment

In addition to cultural changes, the commitment from the top management is generally considered by the industry as an indispensable prerequisite for the successful implementation of any quality initiatives. The quality culture discussed in the previous paragraphs cannot be developed without the full support from top management. Besides financial support, personal involvement from top management is essential. Top management must be involved because they are the ones who create the environment to which all other employees will adapt (Cortada and Woods 1995). Low (1998), Serpell (1999) and Lo (2002) also concluded that the lack of involvement from top management was one of the major difficulties encountered by contractors. Top management must have a proper attitude towards quality accompanied by behaviours before employees can be transformed and are motivated to do the same. Moreover, motivational activities such as rewarding and recognizing employees for their contribution to the successful development of quality culture are also essential. In construction, these incentive activities are rare and the culture of rewards and recognition has yet to be developed, particularly at the site level.

Top management must not view the implementation of a quality management system as an end to quality initiative. On the contrary, it is only a first step towards the everlasting process of continual improvement. A successful implementation of a quality management system of an organization cannot always guarantee good quality products. Developing a good quality culture should be a correct and essential step.

As a brief recapitulation, the role of CPCM is illustrated in Figure 12.1. Quality assurance (many existing quality management systems) can only be considered as a stepping-stone for an organization to implement Total Quality Management. As the emphases of the year 2000 edition of ISO 9000 moved closer to the principles of TQM, continual improvement of an organization and its processes are mentioned in many parts of the standard. Specific guidelines for performance improvement are also given in the year 2000 edition of the standard ISO 9004. While much attention is paid to the measurement, analysis and improvement of processes, specific requirement on the cultural aspect is also mentioned in the standard. To achieve continual improvement, ISO 9000:2000 requires the management to develop both the software (culture) and the hardware (structure) for the improvement process. Clause 8.5.4 recognizes the importance of creating a culture as an aid to ensure the future of an organization and the satisfaction of interested parties.



Legend:

ISO 9001:2000 Clause 8.5.1:

1. The organization shall **continually improve** the effectiveness of the QMS through the use of the quality policy, quality objectives, audit results, analysis of data, corrective and preventive actions and management review.

ISO 9004:2000 Clause 8.5.4:

2. .....management should **create a culture** which involves people actively seeking opportunities for improvement of performance in processes, activities and products.
3. **To provide a structure** for improvement activities, top management should define and implement a process for continual improvement.....
4. **Inputs** to support the improvement process include.....
5. **Financial data** as one of the examples of inputs.

Figure 12.1 The role of CPCM in quality management

In the identification of processes for improvement, financial data is considered as one of the important input from which information is derived. While the previous edition of ISO 9004 offered three models (PAF model, PCM model and Quality-loss model) for collecting and reporting financial data, the year 2000 edition hasn't called out any specific model. After comparing different models proposed by researchers together with feedback from interviews and pilot tests, it can be concluded that CPCM is an effective and practical tool for the construction industry to provide financial data for the purpose of continual improvement of processes. The CPCM approach of quality costs will play an important role in construction related organizations seeking to improve their products in the highly competitive market.

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