



QUALITY MANAGEMENT

An Introduction

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INDEVELOPMENT

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1 INTRODUCTION

Defining quality

Workmanship and craftsmanship are probably the first words that come to mind while describing quality of products. However there are various definitions of quality. J.M. Juran defined quality as fitness for use and takes the point of view of the user to evaluate quality. It is equally possible to evaluate quality from the point of view of the customer, who purchases the product. Customers want the best product for certain customer conditions, like price. Customers are not always the users of the products and services. Production equipment is purchased by the management or directors but usually used by their workers.

Many customers want guarantees about the quality of the products and services that they intent to purchase. The management of production companies are always searching for options to gain a market advantage over competitors. Improving the quality of their products is one option they explore to gain confidence of potential buyers. Obtaining certificates that indicate the quality is another.

Early quality control

The guilds (1300-1800) already protected their customers against bad craftsmanship. They were the ones who first issued certificates about the craftsmanship and quality for the products. Many professions became “protected”. Controllers started to inspect the quality of the products.

Quality Inspection

In the period between 1920 and 1950, quality management focussed on inspecting of the products. The main objective of the inspections was to satisfy the customers. Most companies included a special inspection unit. The inspection results were seldom used to improve the quality of the product or production process.

Quality assurance

During the second world war, the allied forces didn't want to rely on test results alone and wanted guarantees that the bombs, ammunition etc were produced under controlled circumstances. These demands resulted in the emphasis on control of the production processes.

TQM

In the early 1950's Japanese firms and later after 1970's firms in the US and Europe started to adopt a new approach to quality management, moving away from just controlling the production processes to continuously improving the products and production processes. This approach is known as Total Quality Management (TQM).

2 QUALITY INSPECTION

Everything varies

Everything varies, even automatic production processes. Equipment wear out and needs maintenance. The quality of the raw materials varies and the composition of the staff differs. As a result the quality of the products differ. Companies want to protect their customers against inferior products or want to protect themselves against inferior raw materials. As a result, in the 1920's companies started to inspect the quality of outgoing and incoming products.

Test results

When test results of these inspections show that the quality of a (batch of) products is unacceptable, there are various options:

- Demolish and reproduce
- Repair
- Sorting

Sometimes it is possible to blend in the failing batch in a larger volume. This is only possible when the production volume is very large and it is possible to produce a very homogeneous product that meets the specifications, e.g. with the production of paint. This technique cannot be applied in the construction industry where all products are more or less unique.

One of the main concerns of the producers is the effectiveness and efficiency of the inspection process. For example instead of inspecting all products it prefers to use sampling techniques and to measure certain characteristics when it is relatively easy and cheap to do so. It is far easier to inspect concrete sewer pipes in the factory than when they are buried in the soil. It is also far easier to correct a leaking connection prior refilling the trench.

There are two typical errors of inspection results:

- Consumers' risks
- Producers' risks

Consumers' risk

The consumers are at risk when the batch should have been rejected but was not. The consumers' risk can be reduced by setting higher standards for the sample than for the real batch. However this increases the producers' risk.

Producers' risk

Producers' risks are associated with situations in which the batch was rejected where in fact it is perfectly acceptable.

The size of the sample influences the reliability of the measurements. A large sample size will reduce the change on producers' and consumers' risk. The sample size correlates with the quality standards for the batch. Large samples can be very expensive, in particular when destructive methods are used. Producers therefore search for options to reduce the sample sizes, e.g. by formulating higher standards of the sample or by reformulating the standards.

Having said this, it is usually worthwhile to consider a large sample size in the early stage of production. The sample size may be reduced after analysis of the first test results, depending on these test results.

3 QUALITY ASSURANCE

Disadvantages of quality inspection

Inspection of the products alone, have proven to be unsatisfactory for the producers. Failing batches have to be destroyed, repaired or sorted out. All expensive mechanism to retain the confidence of the customers. The inspection techniques themselves are not cheap either.

The beginning of quality assurance

Besides these internal motives, more and more clients are seeking assurance from the supplier that the products are meeting the set specifications. This started during the second world war, when the production of new military equipment and ammunition expanded rapidly, using relatively inexperienced workers to produce them. The allied forces were seeking guarantees that their equipment would operate under all circumstances and that the ammunition was reliable.

Much later in 1970 the NATO formulated these requirements in contract clauses. Suppliers had to provide plausible evidence that its products were manufactured under controlled circumstances and that the product prior delivery had been tested.

Thus quality management moved from product inspection to production control. The initial assumption was that control of the production process would eliminate all possible causes of failures of the products and therefore the products would meet the specifications.

Eliminating causes of variation

In reality the control of the production processes focuses on eliminating all causes of variation. Thus by controlling the variations of all inputs and the production processes an attempt is made to control the variations of the products'/services' quality.

Assignable causes

The production characteristics vary because the equipment wears out but more importantly everybody operates differently. Over time, routine-operating teams will develop an attitude to deliver the minimum acceptable, which they wrongly consider as the most efficient operation. As a result the quality of the process reduces and eventually the quality of the products. The management can easily correct these so-called assignable causes of variations.

Common causes

However there are also common causes of variation. These causes are inherent of the production process or their inputs. To get rid of these causes the management has to change the production process or choose for other inputs.

Standardisation

Quality Assurance focuses on controlling the assignable causes of variation through standardisation and is therefore a way of coordinating efforts between different operating and support units. The production processes are described and formalised in procedures. These processes are closely monitored and failures are described. When the production process does not perform as described in the procedure

corrective actions are required. The monitoring often includes so-called control charts.

Control chart

A control chart is simply a form, which is used to communicate information about the production process. It can be compared with logbooks. It registers a number of parameters like:

- General information about the production, e.g. names of operators, timing, batch number etc
- Alarm parameters to prevent that failing equipment is used
- Product characteristics that measure the actual performance of the production process, similar to inspection results

Monitoring variation

The Control Chart is a means of monitoring variation in the characteristics of a product or service by:

- Focussing on time dimension
- Studying the nature of the variability in the process

Identify causes

Besides earlier mentioned objectives, the principal goal of the control chart is to separate assignable causes of variation from common causes of variation.

The chart helps in preventing two types of errors:

The first type of error involves the belief that an observed value represents assignable cause variation when in fact it is due to the common cause variation of the process. The second type of error involves treating assignable cause variation as if it were common cause variation and thus not taking immediate corrective action when it is necessary.

Control limits

It is necessary to specify the limits within which character values are in control. In most statistical cases, control limits are set within the ± 3 standard deviation of the statistical measure of interest, e.g. average, proportion, the range etc. (The variance of the products' quality will almost always have a normal distribution, as many independent factors influence the performance of the production.)

Analysing control charts

Once the control limits are set, the control chart is evaluated from the perspective of:

- Any points outside the control limit
- Patterns that might arise over time

Out-of-control

If there are any values outside the control limit, this means that the production process is out-of-control. Out-of-control processes may contain both common and assignable causes of variation. An in-control-process contains only common causes of variation.

Once a process is out-of-control, the assignable causes of variation that are producing the out-of-control condition must be identified. If the assignable causes are detrimental to the quality of the product or service, plans to eliminate this source of variation must be implemented. When an assignable cause increases quality, the process

should incorporate this positive feature into the process design.

Trends

Trends or patterns may provide useful information about the product characteristic. For example if the quality is consequently higher than the set standard (centreline) than it may be possible to increase the value of the quality standard. Or when the value of the quality consequently decreases, the pattern may indicate that management has to supervise the production more severely to avoid an out-of-control situation in the future.

It is not that easy to detect patterns, but there are two simple guidelines that indicate patterns:

- Eight consecutive points above/under the centre line
- Eight consecutive points increasing/decreasing value

Need for pairing measures of interest

Usually two measure of interest are used. One to monitor the variation in the process, the other to monitor the process average.

For the process to be considered in control, the value of both measures of interest must be within the specified control limits. Often control charts for the range and the average are paired. However other pairs are also possible.

Customer satisfaction

However processes that are in control are not a guarantee that the customers are satisfied about the product or service. Too many dissatisfied customers often lead to product and production process changes. There are many ways to analyse customer satisfaction.

Percentage of products meeting specifications

A straightforward way of analysing the capability of a process is to estimate the percentage of product or service that is within specifications on condition that production processes are in control. Note that the upper and lower specification limits are not the same as the upper and lower control limits. The control limits are statistical devices and have no relation with the requirements of the product or production process.

Procedures

The procedures have the objective to prevent variations in the production process. The procedures formulise the production, maintenance and management operations. The management has to ensure that the procedures are followed; otherwise the procedures have no or little value.

Designing procedures

There are different ways of developing procedures. Procedures of new operations are often designed. Procedures of existing operations are often based on a description of existing work practices. In both situations it is important to focus on eliminating causes of variations in product characteristics. Thus it is not necessary to control every single aspect of the process.

Design criteria	<p>The procedures of new operations are usually designed on basis of criteria like:</p> <ul style="list-style-type: none"> • Suitability & effectiveness to produce the specified goods • Acceptable to regulators and pressure groups • Efficiency • Ability to correct the production process in out-of-control situations
Existing processes	<p>The design of procedures for existing operations is merely a description of current work practices, in which causes for variations are eliminated. Usually the production floor is heavily involved in the development of these procedures. When the management expects that there is mismatch between the customers' requirements and their products/services, it often initiates projects to improve the products or production process.</p>
Presentation	<p>It is important that the presentation of the procedures accommodates the use at the work floor, where the procedures are needed. It may be possible to present the procedures in the form of flow charts, manuals or electronic documents. Only the relevant procedures should be made available to the responsible officers or units. The procedures should be as precise and concise as possible. Explanations should be attached to the procedure, but not included in the main text.</p>
Disseminating procedures	<p>An important task of the management is to make the procedures available and up to date at the operation levels. Furthermore they have to ensure that every officer has read and understand all relevant procedures and updates.</p>
Risk management plans	<p>Besides procedures for regular operations it is necessary to develop a procedure for situations in which the production process is out-of-control, a risk management plan. The risk management plan assists the work floor and its management to take actions in times of crisis, when they are under pressure. For more information about Risk Management Plans, see also "Project Management for Civil Engineers"¹.</p>
Improvement procedure	<p>The set of procedures should include a procedure to change procedures in order to control the variability of operations better, and to improve the effectiveness and efficiency of operations.</p>
Audits	<p>Quality assurance systems are not complete unless there are audits. Internal audits provide information about the functioning of the quality assurance system and the production process. On basis of audits the quality assurance system can be changed. External audits by independent organisations (e.g. ISO 9000 series) allow customers to get confidence in the products and services. The independent organisations provide objective evidence that the quality of the product is of a certain standard. Most producers intend to sell their goods and services to different clients. Every client has its own set of</p>

¹ Available on this website

requirements. It is difficult and costly to design, produce each product for each individual client. Mass production, through its economics of scale reduces these costs but also the options to accommodate specific customer attributes.

Mass products are therefore designed on basis of common shared quality requirements of the target group. To provide detailed information, accommodating the specific needs of individual customers is equally expensive and most customers are not willing to pay for such information about mass products. The certificates of the independent organisations are a relative cheap measure to get customer confidence.

Quality assurance
techniques in projects

Quality assurance techniques have been successfully applied on all sorts of routine operations, like mass production. It has been recognised that it is far more difficult to apply the technique on design or project operations. Project operations are characterised by high uncertainty of the product, production process and required inputs. Nonetheless an important task of project managers is to ensure the quality of the project outputs. This often implies setting quality standards for the different project activities and monitoring the performance. Actions very similar to quality assurance actions for routine operations. The mere difference is that it is difficult to audit the project and to obtain certificates from external organisations. Furthermore project managers have to build in potential variations to explore unique options to address the customer demands.

4 IMPROVING QUALITY

Motives for improving quality

Quality inspections and quality assurance techniques address the prime motive to obtain customer confidence. The techniques are aimed to prevent and signal failures in production. Many organisations also make efforts to improve the quality of their products and services. An important reason is to improve the efficiency of the production processes through reduction of the quality related costs.

Competition

Competition among companies in the same industry or individuals in the same field may be seen as the driving force for innovation. Companies are constantly searching for opportunities to increase profits and increase their market share. As a result they improve the efficiency of their production processes, reduce the quality related costs and develop new and better products. Lower retail prices and better quality products of competitors affect the expectancy pattern of potential customers. Companies have no choice but to innovate continuously if they want to survive.

This chapter explains the concept of quality costs and describe a philosophy about continuous quality improvements, Total Quality Management.

4.1 TOTAL QUALITY COSTS

Total quality costs

Despite all the efforts to signal and prevent failures, companies still incur costs due to inferior products (losses and waste). The cost related to prevent, signal and as a result of failing products are the so-called total quality costs.

Improvement projects

Improvement projects are initiated when the organisations wants less corrective measures to eliminate deviations of the quality targets.

Quality cost

Insight in these quality costs are needed to assess the importance of the quality related problems, for example by identifying recurring problems.

Exogenous factors affecting quality costs

Preventive measures to avoid failures are often said to reduce the total quality costs and therefore the total production costs. In reality the total quality costs are influenced by a number of external factors, like the market, product developments, developments at suppliers, etc. The quality improvement project may not result in a reduction of the total quality costs. However without the project, most likely the total quality costs would have increased proportionally.

Regulations

Cost reduction is not the only motive for companies to improve the quality of the products. Government regulations with regard to liability of occupational health and safety and environment protection forces companies equally to control their production processes.

Need for records

To get insight in the quality costs the firms need to record its expenditures with regard to its actions to prevent and signal failures

and the consequences of the failures.

Consequences of failures

The internal consequences of the failures, e.g. repairs and waste, are relatively easy to record but the external consequences, loss of clients, reputations are difficult to estimate. Nonetheless estimates should be made as the external consequences can be extremely high and easily exceed all other quality costs together.

4.2 TOTAL QUALITY MANAGEMENT

Since 1970, Total Quality Management (TQM) has become an important philosophy in many companies all over the world. The management of Japanese companies and the Union of Japanese Scientists and Engineers already adopted the ideas of American quality management gurus, like Deming, Juran and Feigenbaum in the 1950's. These gurus developed their ideas during the second world war. Prior 1950 Japan produced shoddy consumer products of poor quality. The management of Japanese companies realised that quality is a vital factor in being able to export consumer products successfully. As a result in many industrial sectors Japanese companies were market leaders by the end of the twentieth century.

Learning organisations

Although there are varies sub-schools, they all concentrate on continues improvement of all aspects of the firm through two "learning" processes:

1. Single loop learning; Improving the existing product and production processes
2. Second order learning; Changing products and production processes

Single loop learning is often the result of innovations from the work floor, while second order learning is a result from R&D, marketing studies and design studies.

Customer satisfaction

Total quality management measures its success on basis of customer satisfaction with regard to all aspects of the product (quality, price and availability). In most societies it is necessary to include the demands of regulators and pressure group in the analysis of customer satisfaction. The customer attributes are translated into measurable terms and subsequently in the product designs and the production process.

Producer's concerns

Besides customers' satisfaction, the different TQM gurus focus on three central themes: Effectiveness, efficiency (lean production) and control of production process. These are the so-called producer concerns.

Organisation culture

Many explained the successes of Japanese companies because of its strong cooperative culture, where the employees and management have similar values and goals and are also strongly committed to achieve these goals. Many gurus were quick to add this aspect in their intervention mix. They emphasise the need for a progressive and

innovative organisation culture and at the same time a culture of working according the procedures.

Intervention mix

Thus total quality management is a mix of statistical process control, design engineering and marketing and organisation culture strengthening techniques.

Intra-organisation customers

An interesting feature in total quality management is the creation of intra-organisation customers. This means that the different units address each other as customer and producer. A unit that produces sketch designs in a road authority not only has to meet the requirements of the government, road users, and road authority, but also that of the unit that uses the sketch design to develop the technical design. This type of customer relationship is also applied when parts of the work are subcontracted and the contractor uses semi-finished products of the principal. The common view is that the principal is the customer of the contractor's product and has the right to evaluate the quality of the product. However many contractors have to work with semi-finished products of the principal and not always meet these semi-finished products the quality expectations of the contractor.

Teamwork

Another important feature of TQM is the creation of teamwork and breaking down the barriers between departments. This seems obvious. You would be surprised to see a goalkeeper of Manchester United or Real Madrid stepping away to let the opponent score because one his teammates made a mistake earlier on. However in quite a few organisations, some with only 10 officers, certain units are completely inactive or non-cooperative when they feel that another unit made a mistake. In particular admin & finance departments are notorious for misusing their financial accountability responsibility.

Internal competition

Interestingly, some gurus emphasise the need for internal competition. They consider internal competition as a force for innovation and productivity increases, but many others feel that cooperation is more effective than competition. Internal competition could lead to a negative working environment. Colleagues backstabbing, sabotage, withholding information and limited willingness to cooperate together are common seen problems. Internal competitions often result in pleasing the boss competitions, when evaluations are not based on objective criteria and measurable performance indicators. The organisations should be careful using and designing internal competitions. The competitors should be exposed to equal circumstances and should be able to autonomously influence their performance. When this is not possible the competitors should compete against a standard, like a handicap in golf. Furthermore the internal competitions should be relatively short in duration and be fun for all competitors. To long competitions become a routine and lose their incentive to innovate. When kept fun, internal competitions tend to cultivate craftsmanship and pride among the employees.

Decentralisation &
Empowerment

According to Juran, authorities related to product and process quality should be delegated to the operator level. Operator self-control means that the operators have the responsibility, knowledge, skills, means, and autonomy to inspect and control the quality. Deming adds that the organisation culture should be open and allow staff to learn unthreatened from mistakes. Many multinationals will emphasise that employees have to make mistakes and failures. They consider that as an indication for the workload of the employee. Mistakes are considered legitimate when they are caused due to uncertainty and unpredictability.