

CHAPTER 2

THE CONCEPT OF QUALITY

2.1 What is quality?

2.1.1 Definition

According to the South African Oxford Dictionary (seventh edition) quality is: a “degree of excellence; general excellence; attribute or faculty; relative nature or character”. For a study of this nature this definition is inadequate in relating the myriad of complex issues surrounding the concept of quality, especially in the building industry.

Quality is more a conformance to requirements in the construction industry. But as the requirements are subject to the expectations and acceptance of the client, and as each client’s perception or view of quality differs, it becomes more difficult to set fixed parameters within which the product must fall to be deemed a quality product. The parameters must be related to the client’s expectations and needs.

Quality is determined by the customer and the marketplace and include all the product’s attributes. Quality includes everything the client expects and requires and is continuously changing. (Hradesky, 1995, p.2)

It is a fact that there is no single definition of quality that will apply to all companies in all industries. Each company must define their own meaning of quality if they are to meet the challenges of modern business which almost always require a recognition and improvement of the quality of the company's product or service. (Hradesky, 1995, p.630)

Quality is often thought of as the fitness for use. The "fitness for use" is the extent to which the product successfully serves the purposes of the user. Fitness for use is determined by the features of the product that the user can recognise as beneficial to himself. It is thus a function of the product as seen by the user, not the manufacturer, merchant or repairman.

Other expressions used for fitness for use are "product performance" and "product effectiveness", but as the word "product" fails to include the service industries, these phrases are not considered adequate. (Juran, 1951, p.2-2)

In this early stage we can see that quality means different things to different people. For the producer quality is "conformance to specifications", but for the customer quality is "fitness for use".

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Today most companies admit that quality is not accurately definable as the client defines it. According to ISO 9000, quality is “the totality of features and characteristics of a product or service that bears on its ability to satisfy stated or implied needs.” Today quality is considered to be more of a process than a product. It is a process where lessons learned are used to change future products to better satisfy the clients needs and expectations.

Quality should be seen as a process and not a result. The process of quality is followed to retain current customers as well as to gain new ones and regain lost ones.

Fitness of use is thought of by some as a goal rather than a definition for Quality. The same is said of “zero defects” and “customer satisfaction”. (Kerzner, 2001, p. 1085)

Simply put, quality is meeting the customer requirements. The term reliability goes hand in hand with quality. Quality and Reliability are not synonyms, as quality is the ability to meet the requirements initially while reliability is the ability to *continue* meeting these requirements. Both are however equally important as reliability is often considered when a product is purchased. (Oakland, 1989, p.5)

In the construction industry this is especially true, as aspects such as life cycle cost takes the maintenance cost of a building into consideration when the initial decision to invest in a property is considered.

Maintenance cost will be directly influenced by how “reliable” the building is. The building’s reliability is dependent on the construction methods, materials, design, etc.

A product “meeting the customers requirements” is not just dependent on its functional characteristics, but also on the satisfaction of ownership i.e. it is a status symbol to own the product. This is not always a factor in choosing who will build the building, but definitely when choosing the architect, engineer and the location of the planned building.

It can be stated that there are two types of quality i.e. quality in fact and quality in perception. Quality in fact is achieved when the producer of the product achieves conformance to specifications. Phil Crosby (1979, p.7) said that quality is “conformance to requirements.” The source of the requirements is however, unclear. The requirements could be those of either the client or the manufacturer.

Quality in perception is the subjective quality as seen by the user. It is based on the belief the customer has in the product’s ability to satisfy or exceed his expectations. Both quality in fact and quality in perception must be given attention in the pursuit of quality goals. If a building is built

according to specifications, but the client believes that it is of poor standard, then quality has not been achieved. The same is true where the customer is satisfied with the building, but where specifications were not adhered to and where latent and patent defects are present even though the client does not know about them.

How to achieve quality in fact is easily understood by the people who physically manufacture a product. Their impact on quality in fact is obvious. The problem arises in their understanding of the impact their actions have on quality in perception. For instance: if a wall is built and parts of it are demolished three times, due to defects, until it complies to all the set specifications, the people who built it would agree that it is a quality wall. However, the client who knows that the wall has been demolished three times, might doubt the quality of the wall. In this case quality in fact is attained, but total quality is lacking because quality in perception was not achieved. (Townsend, 1990, p.3-7)

2.1.2 The characteristics of quality

Quality characteristics are the basic building blocks of fitness for use. Quality characteristics are any feature needed by the product to achieve fitness for use. Several types of characteristics exist e.g. technological (hardness), physical (length, shape, etc), time-oriented (reliability, maintainability), contractual (guarantees) and ethical (honesty).

These characteristics can further be divided into different categories i.e. quality of design, quality of conformance, abilities and field service.

Quality of design is a technical term. It consists of the following steps: Identification of what constitutes fitness of use, choice of the concept or product that respond to the identified need, the translation of the concept into design and specifications, etc.

Quality of design consists of: quality of market research, quality of concept and quality of specifications.

Quality of conformance is the extent of the product's conformance to the design. It is dependent on machines, tools, supervision, workmanship, etc.

The abilities are of importance for products with a longer live e.g. buildings, cars, etc. These abilities i.e. "Availability", "Reliability" and "Maintainability", are time-oriented factors. They are vital for quality.

Availability is achieved through a minimum disruption of use. Reliability is the freedom from failure of the product. It is determined by quality of design and influenced by quality of conformance. Maintainability is a

function of the preventative maintenance and unscheduled maintenance required to keep the product in operation.

It can be stated that availability is the sum of reliability and maintainability.

The “safety” of a product represents the hazard connected with the use of the product while “field use” is the way the product is used by the customer. (Juran, 1951, p.2-4)

2.1.3 The relationship between quality and productivity

There is a close link between quality and productivity. In modern times productivity is often singled out as the root of many problems relating to profit margins and competitiveness. The influence of quality is overlooked or at best deemed less important. This is however, a grave mistake. P.L. Townsend states that “..productivity is not quality. Quality incorporates productivity” (1990, p.6). This translates into the fact that productivity is heavily influenced by quality. Productivity is defined as the achievement of higher output with lower input. By improving quality of work, fewer resources will be wasted. This will lead to a reduction of input while less re-work will mean more products completed in a set period i.e. more output. The influence pattern does not end there. Once quality, productivity and, inevitably, profitability has improved, the workforce should see the benefit of the improved productivity that will, in turn,

inspire them to increase their quality even more. It is further stated that, whereas increased productivity might mean fewer jobs (less resources for the same or higher output), quality can be described as doing the current work better but with the same resources. This description comes in handy when trying to motivate the workforce to improve quality, as it is not seen as something which will cost them their jobs, but something which will have a positive influence on profitability. Profitability in turn will lead to more jobs and higher job security (Townsend, 1990, p.6).

2.2 Quality in the construction industry

Quality, together with cost and time is part of the project triangle. It is of equal importance with cost and time, in that all three have to be controlled if the project is to be called a success.

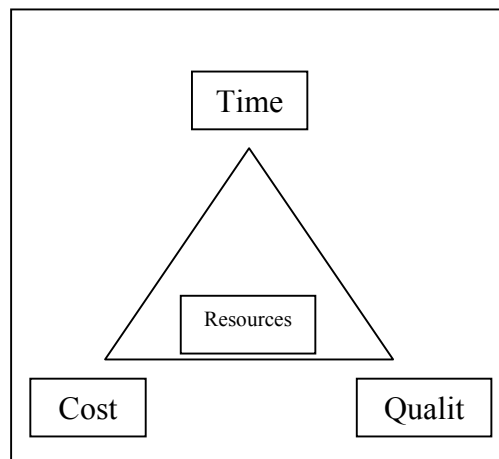


Figure 1

The Project Triangle

There is, however, a problem due to the fact that there are usually plans to control the time and cost aspects of a project, but quite often there is no such plan for quality. Where quality is considered during the planning phase of a contract, it usually does not involve a plan but rather the draughting of specifications and ways of inspecting for defects. As has been said before, one cannot inspect quality into a product. The idea of inspecting is further flawed, as it is end product oriented and the nature of the product, the building, means that the correction of defects involves time and money.

The fact remains that quality is almost always sacrificed first when cost or time constraints come under pressure. This is short sighted as, even though the pressure might be relieved for the time being, it will almost always resurface at a later stage in the contract when the need to correct defective quality will have a negative impact on time and cost. The lack of quality control will also affect the maintainability of the project, as more maintenance will be necessary later in the building's life.

2.2.1 What is quality in construction?

Quality in construction is different from quality in production as the client has a far greater and more direct influence on the quality of the completed building. The reason for this is the fact that the client has

greater input in the design of the product (the building) than is usually the case in production. In production this input is usually restricted to market research prior to and during the design of the requirements a product must fulfil or feedback on the changes that would make a product better suited to the client's needs. It is mostly aimed at a generic product that will be produced more than once. In construction the product is primarily a once-off effort and changing anything in the design will be much harder to effect.

When the quality of a building is discussed, the two types of quality can both be identified. There is quality in perception and quality in fact.

Quality in fact is a function of the input of the customer, project team and the contractor. The design team must obtain and interpret a brief from the client which they must then translate into a design for the building. The ability of the design team, together with the input given by the client, will determine if the building, if correctly constructed, will fulfil in the expectations of the client from an aesthetic and functional point of view.

The project management team and the contractor must also work together to achieve quality in fact. The word "contractor" is meant to represent the main contractor, various sub-contractors and suppliers of materials and equipment. The contractor must follow the guidelines given to him by the project team according to which to build the building. The project team must ensure that this is done. Both must ensure that the

correct materials are used, that the best methods are used, that workmanship is of the required degree and that all components are installed and installed correctly. If all of these are ensured, then the building should represent quality in fact.

Quality in fact will be influenced by the quality of design. Quality of conformance will influence the availability, safety and field use of the completed building.

The actions and competencies of the project team and the contractor will determine quality in perception. If the project team creates an image of competence and professionalism, the customer will be confident that they will ensure a quality in fact product. If the contractor does the work correctly and without major defects to be remedied, then the client will feel the building is “well built.” Both these factors will influence the way the customer perceives the building. If he perceives it as a well designed and constructed building then quality in perception will be achieved. Even if the building is technically well constructed, but the client suspects that there might be hidden defects or he does not have confidence in competence of the project team, then quality in perception has not been achieved. The client’s knowledge and understanding of construction methods and acceptable standards will also have an influence on perception of the quality of the building. The fact remains that even if quality in perception is achieved, but quality in fact is lacking due to for

instance, latent defects in the building, then true quality has not been achieved. This will be revealed later through the occupancy and maintainability of the building.

It must further be noted that a technically quality building that has been delivered late or at an inflated cost or both, might not be viewed by the client as a quality building.

2.2.2 Sources of requirements for quality

There are various sources for the quality requirements for a construction project. The main source is the client who relies on professional project teams to ensure that the building corresponds to his requirements. The requirements are communicated to the design team by the client during the design briefs. Once these are in place, the design team will write specifications that formulate standards to achieve and methods to ensure this achievement by. The drawings and even the bills of quantities will further assist in the definition of the required quality to the contractor.

The specifications are influenced by the law and certain features like compressive strengths, compaction, etc will be based on legal requirements enforced by local authorities, etc. Examples of these include the National Building Regulations (NBR) and the Occupational Health and Safety Act (OHSACT).

There is further the issue of expectations. These expectations are based on what society would consider to be an acceptable level of quality. This is also referred to as industry norms and are what a reasonable client should expect to get from a contractor who has performed a reasonable job.

The word “reasonable” is problematic in that it is subjective. A reasonable inspection from an architect would identify more patent defects than that of a housewife, where the problems could become latent defects. To the contractor a client may be asking for unreasonable quality while the client may consider it fully justified in expecting to get what he feels he is paying for. Conflict often arises when there is a difference of opinion regarding the reasonableness of an expectation by the client and/or his project team.

A further problem arises from the use of standard specifications that are used repeatedly without careful consideration regarding their applicability to each specific project. This can, and often does, cause problems relating to for instance, an acceptable tolerance in floor levels. The contractor might argue that the specified tolerance is unnecessarily strict in relation to the purpose for which the floor will be used, or by what it will be covered. However, this will cause the project team to feel that they are

not getting what they asked for and therefore their perception of the quality of the floor will be negatively influenced.

The above is an example where requirements and expectations may not be aligned. Even though a set standard is expected, and most probably influenced by some standard specification, it might be excessive when the standard that is required to fulfil the function successfully is considered. It might be argued that what the client wants is what he should get, but the contractor might be able to offer the client a saving by having to work within more relaxed parameters. This saving will regularly influence the client's perception of the value for his money and will in turn influence his perception of quality.

The client and the state are not the only role players to influence quality requirements. The contractor himself has quality requirements. The contractor is bound by his contract to the client to deliver a project at a certain quality, on a certain date and at an agreed price. If the contract documentation was given sufficient attention, it should have provided the contractor with the necessary information at tender stage to price for all risks associated with the erection of the building. The contractor would have considered these risks against the abilities of his workforce and that of his sub-contractors and allowed for the cost of re-work and waste which will inevitably be generated.

Once the contract amount has been agreed and the work starts, it is of paramount importance to the contractor that his spending on waste and re-work be avoided or contained as far as possible. To achieve this, he needs to achieve certain quality standards. These might overlap with that of the client and state, but the motivation is different. Whereas the client's requirements are contractual and the state's legal, the contractor's requirements are mainly cost driven. Not only is he concerned with the cost of the project but he must also keep the cost of a bad reputation in mind.

The cost of the project for the contractor is influenced by quality by way of its influence on productivity. If quality is maintained during execution of the works, the contractor will not use more resources than planned, to execute the project within the contractual period. He will have less wasted materials and spend less time repairing work of an inferior nature. This has a direct impact on productivity that aims to achieve a set output with less input. In this case it is a question of achieving a set output with the planned input.

As will be discussed later, the cost of quality goes further than the cost of re-work and waste. There is also a cost connected to developing a bad reputation. Insufficient quality will lose the contractor both current and prospective clients. If the contractor cannot be seen to be able to produce a quality building in the time required and at the correct cost, no client will

return to do business with him again. Clients who are considering contractors to ask tenders from, might also be reluctant to approach such a contractor. In the past, this was not always the case and many clients still preferred the cheapest rather than the best contractor. However, with the decline in workmanship and increase in competition, many clients are beginning to see the merit in identifying and using a preferred bidder rather than the cheapest one.

In summary we can see that the requirements for quality start out as a fairly vague indication by the client of what he wants. This “wish list” is then refined by the design team and translated into industry terms and specifications. In turn, these specifications are then dissected into practical methods and standards by the contractor who then has the task to ensure that they are adhered to. He needs to do this to ensure his profits as well as to comply with his contract with the client and his adherence to the law of the land. The project team must ensure that the design team’s specifications and the government regulations are met and the client will finally determine whether his requirements are met. If all three these role players are satisfied with the quality they receive or achieve, then the project will be a quality project in all senses of the word.

2.2.3 How is quality measured?

To measure means to compare something to a known factor. This comparison can either be expressed in quantitative or qualitative terms. If there is a difference between the item being measured and the goal, then there exist a variance (Hradesky, 1995, p.61).

Quantitative measurement is expressed in specific numerical values, for instance the wall is 20 meters long. Certain things are, however, more easily measured in qualitative terms like smaller, better, faster, etc. This method of measurement can become a problem, as it is often open to the subjectivity of people.

It is obvious from the subjective nature of quality that in order to justify improvements required to it, it is necessary to try and measure it quantitatively rather than qualitatively. The need for improvement is more clearly identified through quantitative terms. Quantitative terms do, however, quite often, set expectations with such clarity that any deviation might be considered a failure.

To measure quality one must first identify the variance between the quality of the actual product and the quality of the ideal (goal) product.

In the construction industry both quantitative and qualitative methods of measurement of quality are applied. Dimensions, compaction figures, tolerances, compressive strengths are all expressed through exact numerical values. The use of mock-up panels and showrooms are also used to measure the completed building against. The latter method is, through its qualitative nature, open to different interpretations and often causes conflict between the project team and the contractor. The fact remains that quantitative standards are more clearly defined than qualitative standards.

The type of measurement described above is usually done by the supervisors of the contractor (the foremen) and by the project team in a supervisory role over the contractor. It measures quality in fact.

But quality is not only about achieving a numerical value or a good resemblance of something, it is also about the perception the client has of the product. If the client views the building as below quality, then a great amount of numerical values will not convince the customer that it is a quality building. To measure the customer's perception is difficult but can be done through interviews and questionnaires to determine the client's satisfaction with the building.

Quality measurement in buildings is complicated by the fact that time can have a big influence on it. Small or undetectable defects at completion

can suddenly become eyesores or dangers a year later, affecting quality in perception or quality in fact.

Quality measurement is closely linked to the measurement of the cost of quality. The cost of quality will be discussed later but it should be mentioned here that measurement of waste, re-work, etc, which is also linked with productivity, gives an indication of the quality of the building process and the completed building.

In the past the quality of a building was addressed in two ways. The design team set various standards during the design phase of the project. These took the form of specifications, preambles, drawings, etc. In most cases the contractor was then left to follow these in order to build a building that conformed to the designed standards. The design team then came and inspected the building to see whether it conformed to the standards. If defects were found, they were pointed out and the contractor had to attend to them. This system has been so generally accepted that most contract agreements make provision for this system.

This system is however, end result oriented, and the fact must be repeated: quality cannot be inspected into a completed product.

Recently efforts have been made to involve the design team in quality control during the construction process, as it was realised that this could

go a long way towards completing projects within the time and cost constraints. The right time for the client and the right cost for the contractor.

2.2.4 The cost of quality

The cost of quality can loosely be described as the costs that would not have been incurred had there not been any quality deviations.

Understanding the concept of cost of quality is vital as this understanding should lead to the identification of these costs which would stimulate quality improvement and provide a basis for a continuous tracking of this improvement (Juran, 1989, p.50).

In most cases, the cost of quality is not easily determined in business and this has led to a lack of focus on these costs. These costs are, usually, scattered throughout the construction process with some easily identified while others are difficult to define and quantify.

The importance in identifying the costs of quality is based on the fact that it translates quality into the language of management i.e. money. It provides something that can be measured, improved and controlled. The cost of quality was once described as a goldmine in which profitable digging could be undertaken, a concept that would find favour with the management of most companies (Juran, 1951, p.5.1).

Due to its long life, the cost of maintaining a building, as influenced by the quality of its construction, is a major driving force for improving quality in the construction industry.

In order to start looking at ways and reasons to improve quality, it is necessary to look at the cost of quality. Once the cost of quality is known it provides a method of assessing the effectiveness of the management of quality and a means of determining problem areas, opportunities, savings and action priorities (Oakland, 1989, p.186). The cost of quality consists of three factors. The cost of poor quality, the cost of appraising quality and the cost of preventing poor quality. These are also called prevention costs, appraisal costs and failure costs. According to J.S. Oakland (1989, p.188-189), failure costs can further be separated into internal and external failure costs.

2.2.4.1 Prevention costs

These costs are incurred before the actual construction of the building. Prevention costs include quality planning, quality assurance, inspection equipment, training and improvement projects, etc. Quality planning involves, amongst others, the cost of time and money spent creating quality-, operational- and inspection plans.

Quality assurance costs overlaps with this and is the cost of creating and maintaining the quality system. Inspection equipment are bought for use during the construction process for instance “Dumpy levels”, ”Squares”, “Levels” etc.

Training involves the development and maintaining of training programs for everyone from management to supervision to labour. Clerical-, communication- and general office management costs are collected as miscellaneous costs.

2.2.4.2 Appraisal costs

These costs are associated with the builder and the client’s evaluation of the construction process and completed building. The costs include verification of materials and methods of construction, quality audits, inspection equipment, etc.

For the client, the cost of verification is covered by the fee he pays to the contract team to ensure a quality building. It further includes fees for inspections by local governments. For the contractor these costs are included in the costs of supervision through foremen and surveyors.

There is also the cost of having compaction and other tests done and although the contractor incurs these directly, it is the client who ultimately

pays for this through the preliminary and general items charged by the contractor.

Quality audits should be undertaken by the contractor to ensure that his quality management system is operating effectively. Costs are further incurred when inspection equipment has to be maintained and repaired.

2.2.4.3 Failure costs

Internal failure costs are costs that are incurred prior to the building being handed over to the client for occupation, in other word, before completion of the building. These costs are usually for the contractor's account.

External failure costs are those costs incurred in correcting defects, after completion of the building, when the client or tenant has occupied the building. External failure costs include costs by the contractor as well as costs incurred by the client due to the failure e.g. loss of rent.

2.2.4.3.1 Internal failure costs

Internal failure costs are incurred prior to the building being handed over to the client and should be based on problems identified by the contractor's quality assurance program. Internal failure costs can be called "Correction costs" as phrased by P.L. Townsend (1990, p.126). A pro-active contract team will also contribute to the identification of defects

that lead to internal failure costs. These costs include waste, rework and rectification, re-inspection and the cost of failure analysis.

Whenever work has to be demolished and re-done or rectified, labour and supervision costs will be incurred. Material will also be wasted in the process. These costs are some of the biggest factors in determining the successfulness of a project in the eyes of the contractor and should therefore receive a great deal of attention.

The cost of investigating failures that manifest themselves in problems like leaks, can also spiral out of control, but is usually more prominent as an external failure cost.

2.2.4.3.2 External failure costs

External failure costs manifest after the building has been handed over to the client and where the client and professional teams then identify poor quality. These can include patent defects that were overlooked or latent defects that could not reasonably have been identified during the post hand-over inspections. These costs include repair and servicing costs, complaints, liability and loss of goodwill.

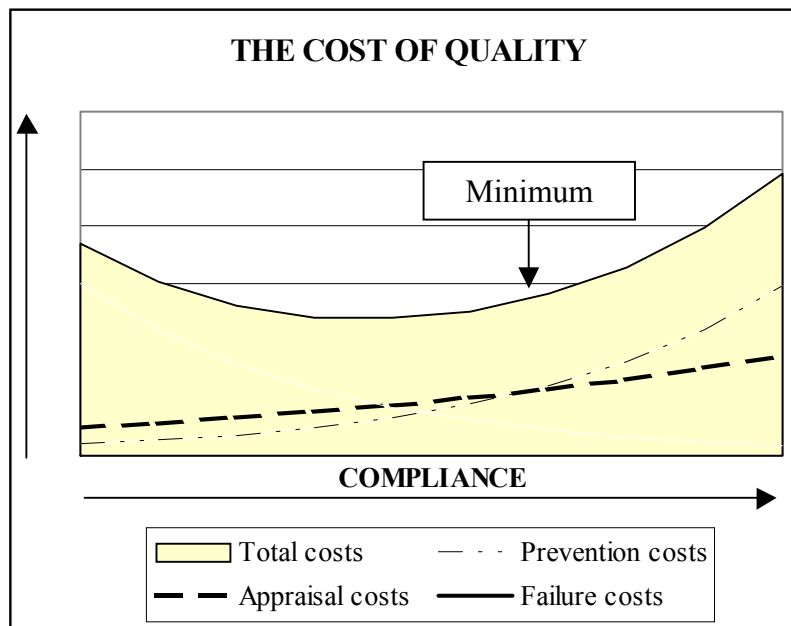
The costs of having to return to a building, identifying the cause of a problem and rectifying it, has a major influence on the contractor's bottom

line. The client further incurs costs when being hampered from using his building to its full extent and in having to communicate problems to the contractor. This, inevitably, will lead to a loss of goodwill which, in the current market, is even more devastating than repair costs as it can prevent a client from using the same contractor in the future.

Failures in building can further cause liability costs. The collapse of a building, or portion thereof, will not only cost the contractor or design team money in litigation but can also damage their image to such an extent that the continued existence of the company becomes endangered.

When sub-standard quality causes the client or the project team to refuse to take possession of the building e.g. refusing to certify that the building is ready for occupation, then penalties are incurred under certain construction contract agreements. These penalties can then also be considered to be failure costs.

It must be noted that the cost of quality is linked to the company's awareness of quality. The more a company becomes aware of the quality issues, the less the cost of quality becomes.



The cost of quality

Figure 2

The relationships between the various quality costs are indicated in the figure 2. This graph demonstrates that striving for a complete elimination of failures may not be cost effective. If too much money is spent on prevention and appraisal, then cost of failure will reduce but the total cost will begin to rise. The opposite is also true i.e. if too little is spent on prevention and appraisal, then the cost of failure will increase and this will increase the total cost. The minimum cost will be effected when a balance is found between cost of failure, prevention and appraisal, as indicated in the graph.

2.3 Conclusion

The cost of achieving quality is high, but pales into insignificance when compared to the cost of not achieving quality. The costs incurred to initiate and maintain a quality management system is obvious costs that are often seen as too high to be justified. However, the cost of rectifying poor quality has become such a part of the everyday construction process that most budgets allow for this cost through factors such as “maintenance allowables” or “snagging provisions”.

The fact remains that the cost of initiating and maintaining a quality system would usually be far less than the cost of rectifying poor quality, both before and after the building has been handed over to the client.

The next question that needs to be answered, is what a quality system should look like. A system called Total Quality Management will now be studied in response to this question.