IMPLICATIONS OF QUALITY MANAGEMENT IN THE GREEK CONSTRUCTION INDUSTRY

by

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Quality is about adding value to the construction process. By applying quality management as a means to improve current project management performance, it is envisaged that each firm will be able to contribute more effectively to the value adding process in the construction supply chain, with the ultimate goal of satisfying the customer. A broad range of integrated quality-focused strategies which include supply chain and customer focus, top management commitment and leadership, training and education of staff from every organisational level at each construction phase, teamwork and collaboration among all project participants throughout a quality-focused supply chain, client's quality awareness and proactive quality management and the appropriate form of contract chosen will enable the successful implementation of quality management systems in the construction industry. A survey was conducted based on interviews with a sample of professionals involved in the design and construction phases of projects to identify the steps taken by firms within the Greek construction sector to ensure quality during project procurement. Amongst others the findings show that, although some initial steps have already been taken, there is still great potential for quality improvements in the Greek construction industry.

Keywords: Quality, quality management, quality management system, ISO 9000, TQM.

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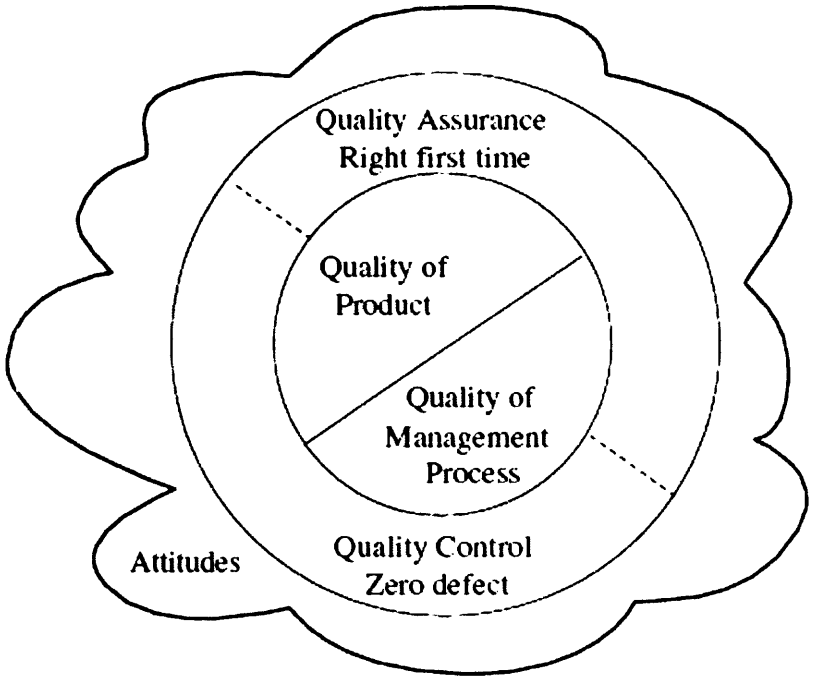
The primary challenge of project management is to achieve all of the project goals and objectives while adhering to predetermined schedules, budgets and specifications. In this direction, for the successful implementation of a construction project, apart from time and costs, also the quality of the product, i.e. the constructed facility, and the construction process need to be effectively managed. Quality assurance and quality control are inherent elements of quality management of projects, as the former constitutes the 'vehicle' of achieving the quality objectives, while the latter is its 'technical arm'. To ultimately attain high quality on projects, quality assurance and control and more generally the established quality management system need to be integrated within a quality culture environment (figure 1).



However, attainment of high quality levels in the construction industry has long been a problem. Many management systems focus on the control of time and cost and try to ensure quality through 'after the event inspection', carried out at a "sub-management" level (CIRIA, 1992). Apart from that, the culture in construction is dominated by short-term financial considerations, which, in turn, result in adversarial relationships and lack of mutual trust and cooperation, all of them being detrimental to the achievement of satisfactory quality standards (Shammas-Toma et al., 1998). Hence, great expenditures of time, money and resources, both human and material, are wasted every year. On the other hand, construction companies are confronted by fierce competition, struggling with unstable market conditions, whilst clients are becoming increasingly more knowledgeable (Pheng and Hong, 2005) demanding improved quality of products and services. As highlighted by Danforth (1987), sited in Pheng and Hong (2005, p.36), '*quality is no longer a luxury, but is critical for survival*'. In this direction, the adoption of a more integrated approach for the successful quality management of projects is long overdue for the construction industry.

Developing an excellent service-culture that is unique to the operations of the contracting firm can be a strategic differentiated factor that will help the contractor gain sustainable competitive advantage.

But according to Pheng and Hong (2005), quality management goes beyond competitive advantage through functional excellence; it has to become a strategic organisational concern based on continuous improvement (Garvin, 1988). Quality is the key to value creation and thus it should be treated as a fundamental part of the organisation's strategy (Pheng and Hong, 2005). In this direction, a shift from a simplistic product quality view to a total quality focus is required (Toakley and Marosszeky, 2003). A broad range of integrated quality-focused strategies which include supply chain and customer focus, training, top management commitment and leadership (Toakley and Marosszeky, 2003) will enable the transition from the profession-based scenario to a project-oriented team-based scenario, mutually rewarding for all parties (Pheng and Ke-Wei, 1996). Apart from that, there is an urgent need to replace the inspection-oriented quality system, which is highly prevalent in the construction industry, by prevention-oriented quality management (Pheng and Ke-Wei, 1996). The end results will boost productivity, reduce waste and rework and save costs by doing the right things right first time (DRIFT) rather than simply doing them right (Pheng and Ke-Wei, 1996). Hence, it is obvious that a more systematic approach to achieve quality is required. Firms with traditional quality management methods will no more be able to survive in the market (Abdul-Rahman, 1996), or, to borrow a phrase from McCabe (1996), "*Get better of get beaten*".

2.1. DEFINING QUALITY

Quality, like beauty, can be perceived in a different way by each person. The vagueness of the concept of quality is reflected in Garvin's (1988, p. xi) quote:

"Quality is an unusual slippery concept, easy to visualise and yet exasperatingly difficult to define."

The academic literature has provided a variety of definitions of quality with significant diversity inherent in them. As Reeves and Bednar (1994), sited in Soltani et al. (2008), point out, this diversity shows that the concept of quality is so broad and includes so many components that it would be useless to try to encompass them all in a single model.

Despite the fact that the various perspectives of quality can cause confusion to managers and potentially bring conflict, the organisation can benefit from such multiplicity, in that it can adopt a broader view on quality and thus avoid the 'blind spots' of each single approach (Garvin, 1988).

Defining quality in construction is even more difficult for several reasons. Firstly, the construction industry is highly differentiated and fragmented and also each project is unique, with specific characteristics, a "single-order - single-production" product. Moreover, in construction the needs to be satisfied include not only those of the client/owner, but also those of the society and those of the supplying organisation itself - the design professional and the constructor (Chung, 1999; CIRIA, 1992), which also differs from project to project. The needs of the client are likewise threefold: they may be considered as a triangular relationship of scope, cost and schedule (CIRIA, 1992). In this way, a quality product in construction is one that meets all specified requirements at optimum cost and time.

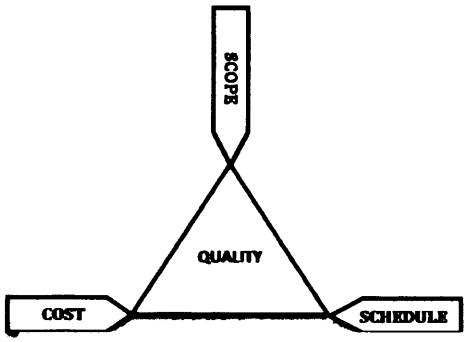


Figure 2. The project management triangle

Arditi and Gunaydin (1997) make a distinction between *'product quality'* and *'process quality'* in the construction industry. 'Product quality' is the quality of the elements that relate directly to the physical product, such as the materials, equipment and technology used when building a structure, whereas 'process quality' refers to the quality of the process that is followed during a project, for example the way that the project is organised and managed from inception to completion, which obviously affects the quality of the final product (Arditi and Gunaydin, 1997).

Arditi and Gunaydin (1997) also differentiate between *'quality in fact'* and *'quality in perception'*; that is *'meeting the specifications'* and *'meeting client's needs and expectations'*, respectively. McConachy (1996; sited in Toakley and Marosszeky, 2003) calls this "the dual-dimensional model" of project quality: *'conventional'* project quality (objective matters, such as technical requirements, schedule and cost) and *'contemporary'* project quality (subjective matters, such as customer satisfaction, contractual relations, community impacts etc.). In other words, a high quality product does not always satisfy the customer and vice versa. This may be also related to the fact that the client in construction is the owner of the facility but not necessarily the end user.

Following these, Wilkinson's (1998) definition of quality, sited in Soltani et al. (2008, p. 464) as '*fitness for use*', reflects better the true meaning of quality in the construction industry, including both '*quality of design*', i.e. how a customer's requirements are translated into a set of specifications, and '*conformance to the design*', i.e. how the construction process and the final product conform to the specifications of the design standard.

The stated project's requirements, according to Arditi and Gunaydin (1997), should be adequate in three dimensions:

- the *legal*, i.e. quality in terms of professional liability,
- the *aesthetic*, for example how a building blends into its surrounding – which is a subjective issue though –
- and the *functional*, taking into consideration issues such as ease of operation, ease of maintenance, energy efficiency etc. (Arditi and Gunaydin, 1997).

When evaluating the service quality achieved in construction, it can be categorized into the following three dimensions (Lewis, 1995; sited in Love et al., 2000):

- *hygiene factors* or expected/ demanded quality (Toakley and Marosszeky, 2003): those elements expected by the customer and will cause dissatisfaction if not delivered;
- *enhancing factors* or attractive/ exciting quality (Toakley and Marosszeky, 2003): attributes and characteristics of the final product that pleasantly surprise the customer but, when not delivered, they do not necessarily cause dissatisfaction; and
- *dual threshold factors*: those things which when delivered above a certain level of adequacy lead to satisfaction but when perceived to be below that threshold cause dissatisfaction.

Virtually, quality is about adding value to the process. Each activity undertaken in the construction supply chain should add some value to the final product; hence each project participant plays a fundamental role to the successful procurement of projects (Love et al., 2000). By applying quality management as a means to improve current project management performance, it is envisaged that each firm will be able to contribute more effectively to the value adding process in the construction supply chain, with the ultimate goal of satisfying its customer (Love et al., 2000; Abdul-Rahman, 1996). Good management, project management and quality management should all supplement each other (Abdul-Rahman, 1996).

2.2. THE FOUR STAGES OF QUALITY MANAGEMENT

Quality management embraces all the activities of the overall management function that determine and implement the quality policy. In the construction industry, quality management involves all aspects of a project and must be an integral component in the management of a project (Abdul-Rahman, 1996). Dale (1999) identifies the following four levels of quality management: inspection, quality control (QC), quality assurance (QA) and total quality management (TQM). Figure 3 shows the hierarchical progression of quality management from one level to another.

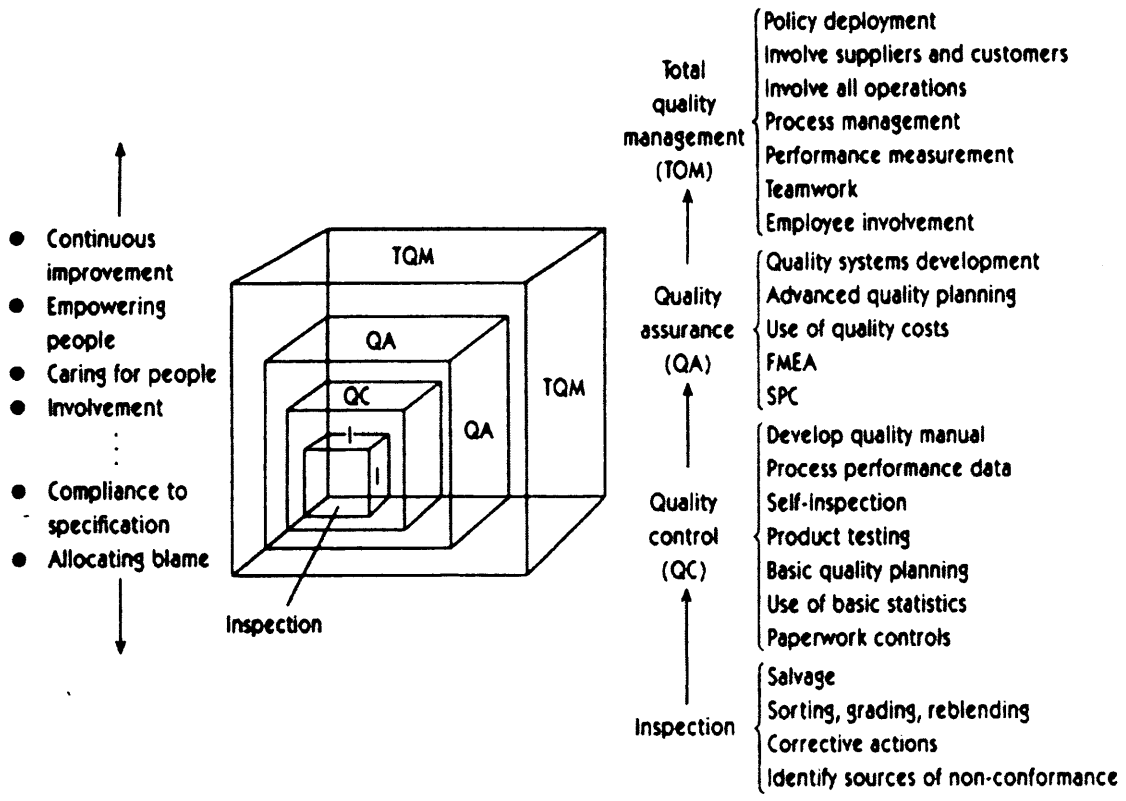


Figure 3 The four levels of quality management (Dale, 1999)

- *Inspection*

Inspection is an after-the-event screening process where the conformity of the characteristics of the product is assessed against a specification or performance standard; it is an activity with no prevention content emphasising on reactive corrective actions (Dale, 1999). Inspection is widely used in construction, as the completed structure is evaluated according to its conformance to the drawings and specifications.

- *Quality control (QC)*

Quality control can be regarded as an extension of inspection. It mainly refers to the activities carried out during and after the construction process aiming to prevent or eliminate incidents of non-conformance (Chung, 1999) and it basically differs from inspection in that it employs more sophisticated methods and systems, tools and techniques such as statistical analysis, etc. (Dale, 1999). In construction, the random sampling and testing of concrete and other materials on site is one of the cases where QC is used.

However, inspection and QC are retrospective (McCabe, 1998). The organisations that adopt these approaches to the management of quality operate in a 'detection type mode' - that means finding and correcting mistakes - and make little effort to learn from those mistakes (Dale, 1999; McCabe, 1998). This has several implications. Firstly, in an environment in which the focus is on removing defects and problems before the product reaches the client, rather than preventing them occurring in the first place, a culture of conflict is cultivated and people refuse to accept responsibility trying to switch the blame to others (Dale, 1999). The result is poor, little or inadequate communication and cooperation within the entire construction process, antagonistic relationships and lack of mutual trust within the project coalition (Shammas-Toma et al., 1998). Another major drawback of this 'inspectoral system' of quality control in construction is that many building defects are covered up by subsequent construction work and thus they cannot be identified in the final inspection (Chung, 1999). Unlike consumer goods, defective works in construction are very difficult, if not impossible, to be replaced (Chung, 1999) and easier to be concealed. As a consequence, the clients in this case find themselves paying high prices for defective works that do not satisfy their needs (Pheng and Hong, 2005) and are left with a great source of expenditure in the years to come (Chung, 1999).

- *Quality assurance (QA)*

Quality assurance is an overall system of monitoring activities and a procedural mechanism to formalise actions, which aims to prevent quality deviations and to give an early warning of poor quality (Love et al., 2000; Abdul-Rahman, 1996). QA includes activities such as monitoring quality performance, analysing non-conformance data, taking corrective action to prevent repetition of mistakes and feeding data backwards and forwards (Dale and Cooper, 1992). It focuses on prevention of quality deficiencies and on elimination of labour inefficiencies, which minimises the risk of making mistakes in the first place, thereby reducing the need for rework, repair or reject (Chung, 1999; Love et al., 2000). Quality control is part of QA since it is basically comprised of the specific procedures, such as planning, checking, reviewing etc., involved in the QA process (Arditi and Gunaydin, 1997). To practice quality assurance, an organisation has to establish and maintain a quality management system in its daily operations (Chung, 1999). To be comprehensive and effective, the QM system must be developed and judged according to a reference base (a quality system standard, as for example ISO 9000) so that improvements can be made (Dale and Cooper, 1992).

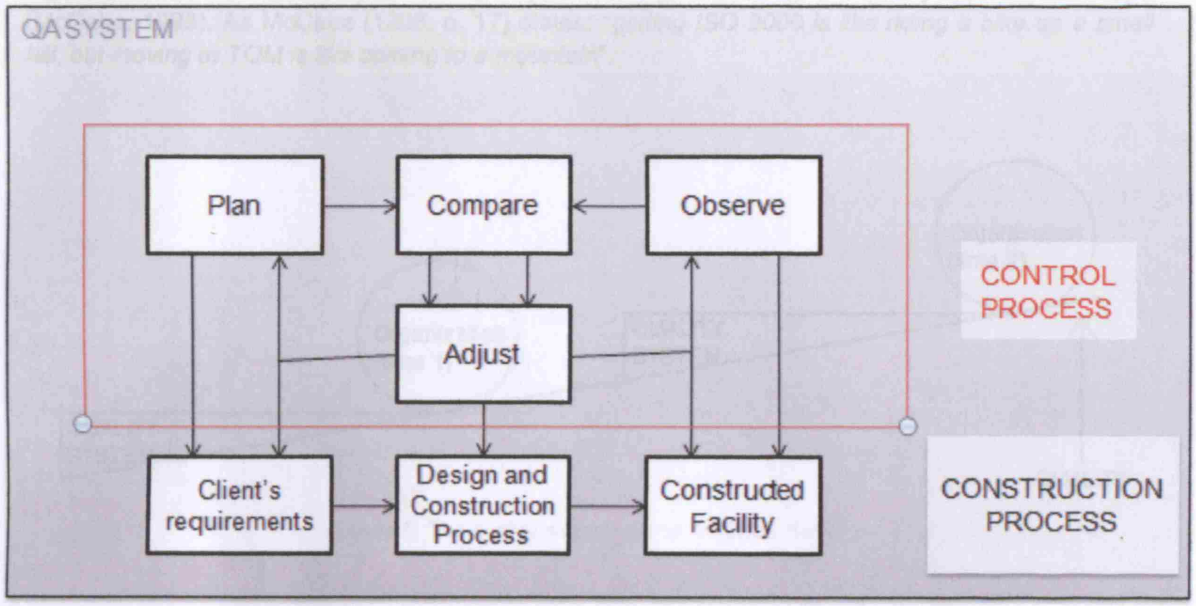


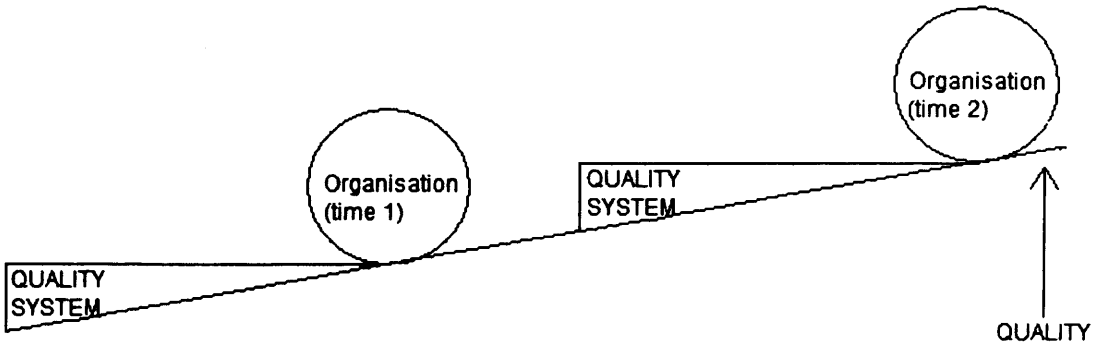
Figure 4: The quality control system (red) within the overall QA system (adapted from Burrill and Ledolter, 1999)

The adoption of QA in the construction industry came, to a large degree, not so much on the basis of long-term improvement but as a result of large client requirement. Clients needed to ensure both that their contractors had the mechanisms to deliver quality and that they kept records to prove that they were doing so (Ferreira and Rogerson, 1999). For this reason, they made the implementation of an effective, or even certified by a third party (i.e. ISO 9000 or formerly BS 5750), quality management system a contractual requirement (Chung, 1999; McCabe, 1996). As a consequence, many firms took the certification route from fear that failure to obtain registration would result in their removal from tender lists (McCabe, 1996) or because 'everybody else is doing it' (Love et al., 2000) or because they perceived it as a panacea for their problems. Until today, very few organisations in construction have grasped the strategic significance of the quality philosophy, whilst the majority of them perceive the investment in quality systems solely a marketing tool (Love et al., 2000).

Firms that practice QA for improving their own efficiency and not just for marketing purposes are those that benefit most from it, as QA can increase the effectiveness of their operations by the more systematic use of procedures (McCabe, 1996). Having developed a more systematic method of working, communications both within the organisation and throughout the supply chain can be improved and mistakes avoided (McCabe, 1996; Chung, 1999). Thus time and money can be saved and higher productivity achieved. These improvements in performance lead to increased customer satisfaction and better customer and staff morale (Love et al., 2000).

But while there are great benefits to be gained from implementing QA, it is seen as a limited approach because it only focuses on how procedures can be adjusted so as the product/ service being supplied satisfies a specific quality standard (Toakley and Marosszeky, 2003). Its main weakness is that it does not link the quality of management processes with the quality of the final product (Toakley and Marosszeky, 2003). The ISO 9000 quality system, although it comprises standards addressing both quality assurance and quality management (Arditi and Gunaydin, 1997), is generic and represents the minimum requirements that a quality system needs to have in order to ensure conformance to client's requirements (Love et al., 2000). Moreover, although the ISO 9000 series aim at preventing non-conformity at all stages, the standard is not prescriptive as to the means of prevention, so registration does not imply that non-conformities will not occur (Dale and Cooper, 1992). Thus gaining ISO registration and practicing QA should be merely viewed as the "*first stage on the never ending road to quality*" (McCabe, 1996, p.17). This route to continuous improvement is the process called Total Quality Management (TQM).

Figure 5 shows how quality systems help to push the organisation up the quality improvement slope (McCabe, 1998). As McCabe (1996, p. 17) states: "*getting ISO 9000 is like riding a bike up a small hill, but moving to TQM is like coming to a mountain*".



- *Total Quality Management (TQM)*

While the ISO standards provide the guidelines for end product and service quality (Love et al., 2000), TQM provides the environment for creating a total quality culture throughout the organisation. TQM is a company-wide approach to quality as it involves the application of quality management to all aspects of the organisation, including customers and suppliers (Dale, 1999). A TQM system is the 'big picture' and is concerned with all the activities conducted by a firm aiming to achieve internal and external customer satisfaction (Arditi and Gunaydin, 1997).

Figure 6 depicts the main elements of a quality system in construction. At the centre of the system is the customer-supplier interface, highlighting the importance of addressing quality both at the organisational level and in the interaction with the customer.

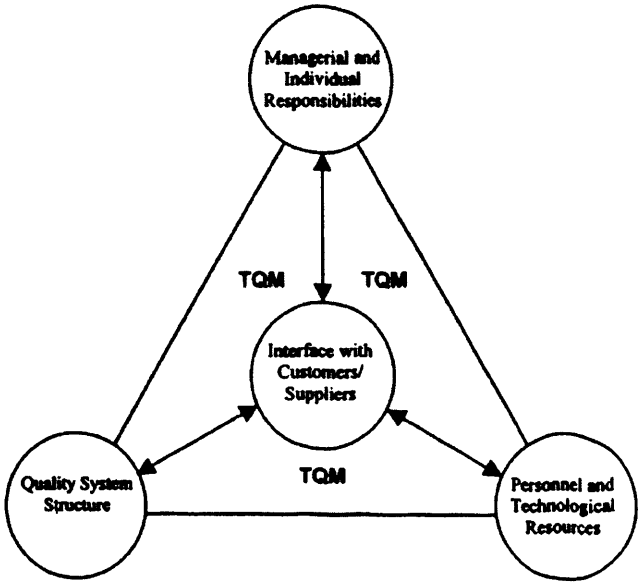


Figure 6 Key aspects of a quality system (source: Love et al., 2000)

The biggest problem of moving from QA to TQM is the high level of ambiguity in the TQM concept which makes it difficult to develop a universally applicable methodology and explain the end results of TQM implementation, in contrast to ISO 9000 where a certificate awaits those who have successfully demonstrated to an accredited third party that they are complying with the standards (McCabe, 1996; Soltani et al., 2008). In essence, TQM needs to be tailored to the organisation (Soltani et al., 2008). But still, as McCabe (1996, p.17) points out, the '*transition from writing procedures to changing culture*' is not an easy task. Total quality is a process of change and apart from a total change in organisation culture it requires shifting of responsibility to management and a true quality attitude of everyone in the quality improvement process. TQM is a '*people-oriented, management-driven, customer-focused management philosophy*' (Saylor 1992, sited in Soltani et al., 2008, p.467) that can bring lasting benefits (Brown 1993, sited in McCabe, 1996).

Figure 7 shows the progression from simpler methods of quality management to the TQM philosophy and their respective effect on quality and business performance.

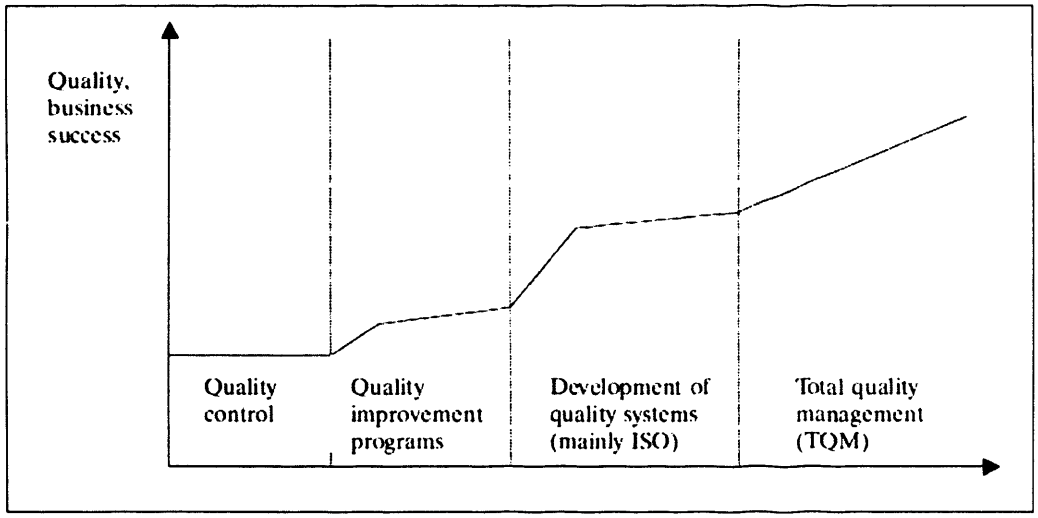


Figure 7 Efficiency of quality management methods (source: Oakland, 1993)

Next, some of the key issues are presented that need to be addressed before the implementation of quality management initially, and the transition to TQM subsequently can be facilitated by construction organisations.

2.3. THE COST OF QUALITY

When an organisation invests in measures to achieve high work quality, the primary concern of the top management is the cost benefits of quality and in particular the cost of achieving quality and the costs derived from failing to do so. This is defined as the '*cost of quality*' (QOQ) (Burrill and Ledolter, 1999). Quality related costs are regarded as a primary criterion of measuring quality performance when valid comparisons can be made (Dale, 1999).

Quality costs consist of the cost of prevention, the cost of appraisal and the cost of deviation or failure (Burrill and Ledolter, 1999; Arditi and Gunaydin, 1997). *Prevention costs* are those costs derived from activities aiming to avoid deviations and errors occurring in the first place, such as quality planning, staff training or, in the case of ISO 9000, modifying work procedures to adhere to quality standards. *Appraisal costs* include the money spent to evaluate the final product or service against the specified requirements. Inspection and testing are typical examples. *Failure/ deviation costs* are all the costs resulting from not meeting the requirements. Deviation costs are incurred both on the construction site and after the completed facility is delivered to the client. These are costs due to scrap, rework, supplier error, price reduction due to non-conformity etc. and repair costs from replacing inadequate material, workmanship and equipment costs for correcting errors etc. respectively (Arditi and Gunaydin, 1997).

As stated by Roberts (1991, sited in Chung, 1999, p.9) "*quality does not cost - it pays*". Through the implementation of a proactive quality management system, which focuses on prevention of rejects and wastes, increased savings on total costs of construction can be achieved through elimination of wastes and reduction of defects and rework (Pheng and Ke-Wei, 1996; Chung, 1999).

As shown in figure 8, by investing in a quality system that costs only a small percentage of the total project value (the prevention cost), the failure cost drops significantly resulting in great savings. The economic benefit from doing it right the first time is obvious.

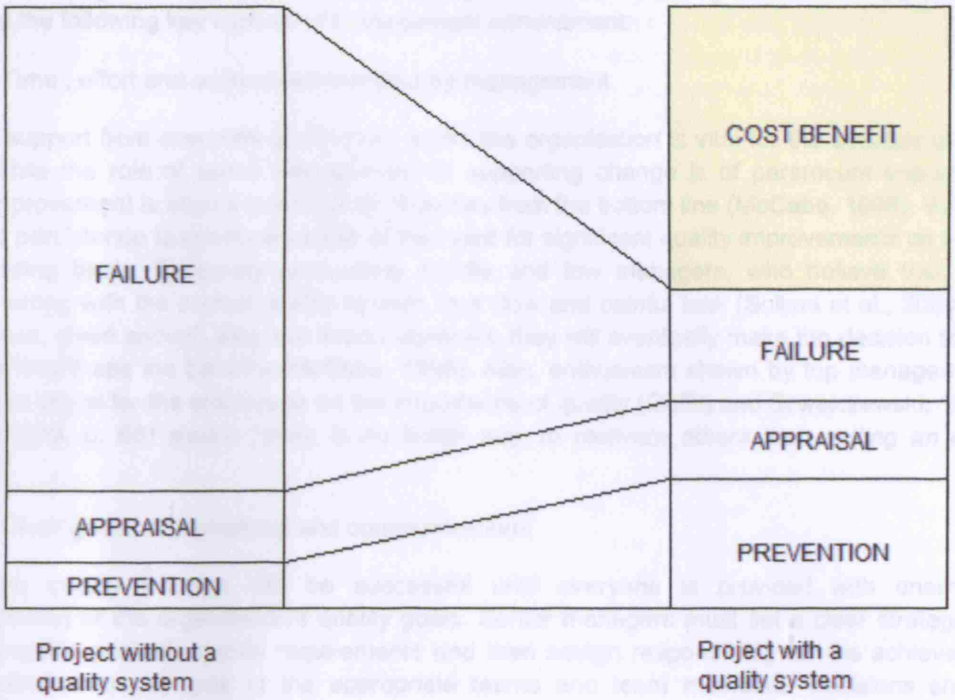


Figure 8: Costs and benefits of quality management (source: Pheng and Ke-Wei, 1996)

While there are great benefits to be gained from the prevention-appraisal-failure (PAF) categorisation of quality costs, such as identification of quality costs and training of staff on quality costing, one of the model's main drawbacks is the difficulty of distinguishing many quality related activities 'in grey areas' from the non-quality ones, thereby impeding the identification of prevention costs (Dale, 1999; Toakley and Marosszeky, 2003). But, within a total quality perspective, the most important limitation of the PAF approach is that it considers only the process costs and ignores the 'value enhancements' derived from the continuous improvement of processes and services with a customer focus (Toakley and Marosszeky, 2003). Thus, a broader categorisation that measures only the cost of conformance and the cost of non-conformance seems to be more appropriate when evaluating quality performance: the so called *'process cost model'*, where COQ=COC+CONC (Dale, 1999; Toakley and Marosszeky, 2003).

2.4. TOP MANAGEMENT COMMITMENT AND LEADERSHIP

Top management commitment is widely recognised as being an essential prerequisite for the success of quality management. This commitment must be fully accompanied with a thorough understanding of the quality concept. Management must demonstrate its commitment to quality through action and also reflect it in the company's policy. Actions speak louder than words and unless every employee realises that continual improvement of the management of quality is fully supported by those in positions of authority, they will resist to any change initiatives. Symbolic leadership is thus needed to articulate the organisation's vision and strategic direction to the employees (McCabe, 1998; Love et al., 2000b).

Unfortunately, in construction, cost and profitability are the most common forces driving firms' policies (Shammas-Toma et al., 1998), and that, in conjunction with the senior managers' lack of in-depth knowledge, confidence and ability to create a quality-focused environment (McCabe, 1996), most often results in poor quality management practices and superficial implementation of quality management systems.

Goffin and Szwejczewski (1996), after conducting a research on quality awards winning companies, identified the following key aspects of management commitment:

- Time , effort and enthusiasm invested by management

Gaining support from everyone at all levels within the organisation is vital for the success of QA and TQM. While the role of senior management in supporting change is of paramount importance, in reality improvement is most powerful when it comes from the bottom line (McCabe, 1996). But it takes time and persistence to convince people of the need for significant quality improvements on a regular, never-ending basis. Especially persuading middle and low managers, who believe that there is nothing wrong with the current quality system, is a slow and painful task (Soltani et al., 2008). But in most cases, given enough time and encouragement, they will eventually make the decision to 'buy in' because they'll see the benefits (McCabe, 1996). Also, enthusiasm shown by top management is a quite clear signal for the employees on the importance of quality (Goffin and Szwejczewski, 1996). As Chung (1999, p. 68) states: *"there is no better way to motivate others than setting an example yourself"*.

- Clear goals, organisations and communications

No single quality initiative can be successful until everyone is provided with unambiguous understanding of the organisation's quality goals. Senior managers must set a clear strategic vision concerning the project's quality requirements and then assign responsibility for the achievement of each individual quality goal to the appropriate teams and team members. Decisions should be delegated to those who must implement them, although top management needs to maintain control over certain key decisions (Pheng and Hong, 2005). By getting the site teams to set their own priorities for quality improvements and thereby placing the people at the operational level in control of events, the so-called 'low level change' is facilitated (McCabe, 1996). In this way, ideas from both above and below can converge to set clear quality goals (Goffin and Szwejczewski, 1996). But for this to happen, an organisational structure that supports rather than hinders their achievement is needed. As Burnes (1996, sited in McCabe, 1998) suggests, the appropriate structure is a flatter structure with emphasis on horizontal processes. Hence, top management must remove any barriers inherent in the organisational structure that prevent employees focusing on their goals, encouraging them in this way to 'work smarter, not harder' (Goffin and Szwejczewski, 1996; Soltani et al., 2008). In order to achieve the desired quality outcome, top management has to communicate clear goals not only to its own employees but also to its suppliers and the rest project coalition.

- Strong focus on staff; training and teamwork

The key to success of any quality improvement effort is people. A quality system is only a means to an end; people make it work (Chung, 1999). Hence, in order to promote quality improvements, management must continuously invest in training and education of their staff at all levels, as each is interrelated. Without proper educational background and training, the quality management system will fail because however detailed the client's requirements are translated into project specifications and however well the quality system is designed, the firm will not be able to provide a quality service and design/construct a high-quality facility if its employees are not professionally competent to carry out the work (Pheng and Hong, 2005). Moreover, the lack of quality awareness by both office staff and site personnel inhibits quality from being improved beyond just being fit for purpose and meeting specifications, as there are no other incentives to promote quality improvement apart from reducing rework (Abdul-Rahman, 1996). Thus the primary goal of the training effort should be to develop further the skills and abilities of all levels of labour and staff in order to enable them to control quality and identify potential sources of problems more effectively, and ultimately bring about improvement (Pheng and Hong, 2005; Shammas-Toma et al., 1998). The management initiative to quality training can be addressed through quality seminars, tailored to fit the goals set, as well as through encouraging on-the-job experience, learning from colleagues and actively seeking new knowledge

(Goffin and Szwejczewski, 1996). The careful selection of employees can also influence the success of the quality management system. However, the transient nature of the construction workforce and the high labour turnover may make it more difficult to train workers, especially craft labour (Arditi and Gunaydin, 1997). The job-hopping site teams, switching from one project to another and from one company to another, although they should be the prime movers in the management of quality, tend to treat quality less seriously due to insufficient time allowed to realize how to make a significant contribution to quality on site. Thus quality awareness needs to be instilled into them in order to be carried to their next employment. Generally, quality training in an organisation must be an ongoing process (Chung, 1999). It is required not only when the quality system is first implemented but also after the system is in full operation (Chung, 1999), so as to move from simply adhering to predetermined quality standards and short-term success to long term benefits from TQM and continuous quality improvement.

In most cases, proper training leads to high degree of teamwork and enthusiasm for quality. This is significantly important as in the construction industry teams, not individuals, are those responsible for project performance. Management should promote this team approach both at the company and at the project level and seek for constructive contribution from everyone. Moreover, if any quality improvement effort is to succeed, senior managers have to give up the traditional '*management by control*' style of managing and adopt a '*management by participation*' kind of style (Arditi and Gunaydin, 1997). Only if they relinquish the strict directive role that their position tends to imply and show that they value everyone's ideas, will they get useful debate in team meetings and consequently gain major benefits from 'team learning' (Pheng and Hong, 2005; McCabe, 1996).

One of the main reasons that top managers in many cases show low or inadequate support and commitment to quality management and demonstrate unwillingness to implement change is that firefighting or 'solve the problem when it appears' is much more preferred, especially in the construction industry (Abdul-Rahman, 1996). Apart from that, senior managers tend to be more committed to the *status quo* and usually they avoid taking risks, which in turn results in treating any quality improvement initiative with the narrow-minded view that it is possible to do well without it (Soltani et al., 2008). As a consequence, detailed quality planning and prevention of non-conformance are not placed in high priority in the day-to-day management of projects. On the other hand, a practical quality plan is more cost-effective, as it minimises idle time and optimises resource usage (Abdul-Rahman, 1996). Moreover, it reduces the chance for rework and waste of material. So it is obvious that quality planning, focused especially on critical activities, is an important aspect of top management commitment to quality, required to reduce unproductive time and effort and ultimately improve quality performance.

2.5. TEAMWORK AND PROJECT-WIDE COMMITMENT TO QUALITY

Clearly, the whole construction industry is project-oriented, so improved quality performance must be project-related and include the whole project team (Pheng and Ke-Wei, 1996; Arditi and Gunaydin, 1997). All firms involved in the procurement of construction, especially these providing professional services like architects, engineers and designers, need to recognise that in order to improve their service quality they must have a quality culture in place (Love et al., 2000). The absence of quality focus in the supply chain is detrimental to the project success, as it is a major cause of rework, delays and cost overruns. To develop a quality culture and achieve superior project quality, it is of high significance to get everyone, including contractors, subcontractors, suppliers, designers, project managers and above all the client, involved in the quality process and develop a true quality attitude (Pheng and Ke-Wei, 1996). One of the major challenges is to communicate the importance of quality management to sub-contractors and their workers and penetrate the quality improvement process into their work, as they are the ones who actually undertake the on-site work (Pheng and Ke-Wei, 1996). Incentive schemes, training on the concept of quality, assistance and advice as part of a normal routine, feedback on more efficient ways of working and managing the project and multi-trade

meetings with the main contractor are all important elements that make a positive contribution to the improvement of quality during construction and favourably affect the project's overall performance (Abdul-Rahman, 1996; Pheng and Ke-Wei, 1996).

But apart from the overall commitment to quality throughout the construction supply chain, the relationship among the parties involved in the process has also a great impact on the project outcome. The quality of any stage in the process is dependent on the quality of the previous stages (Arditi and Gunaydin, 1997).

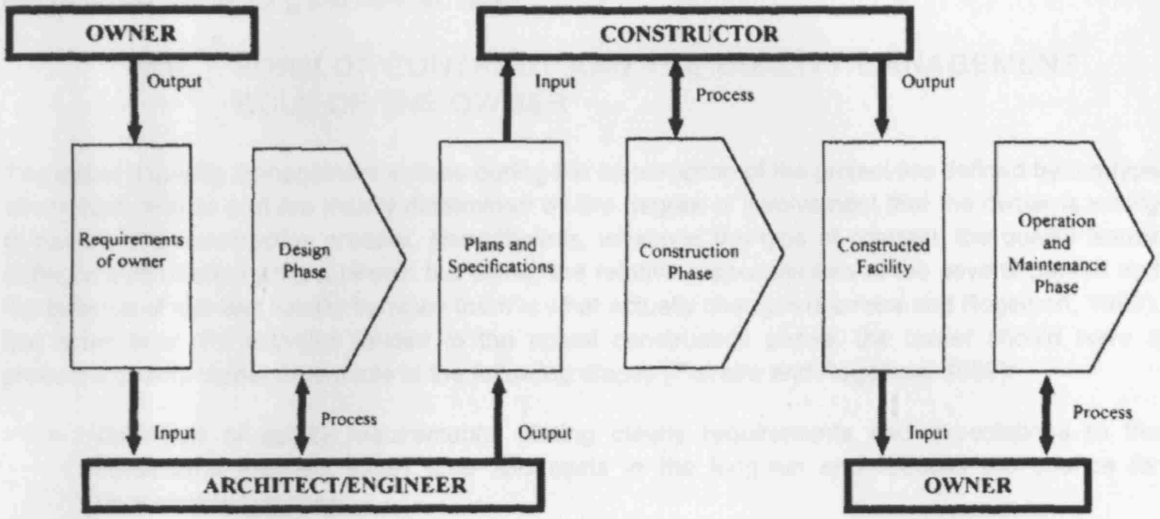


Figure 9: The 'carry-over' effects of quality in the construction process (source: Arditi and Gunaydin, 1997).

Thus, each firm must realise that at some point they are both a customer and a supplier (figure 10) and should seek to identify, meet and hopefully exceed its client's needs (Arditi and Gunaydin, 1997; Love et al., 2000). In this way, each can provide superior quality service and contribute to the successful procurement of the project.

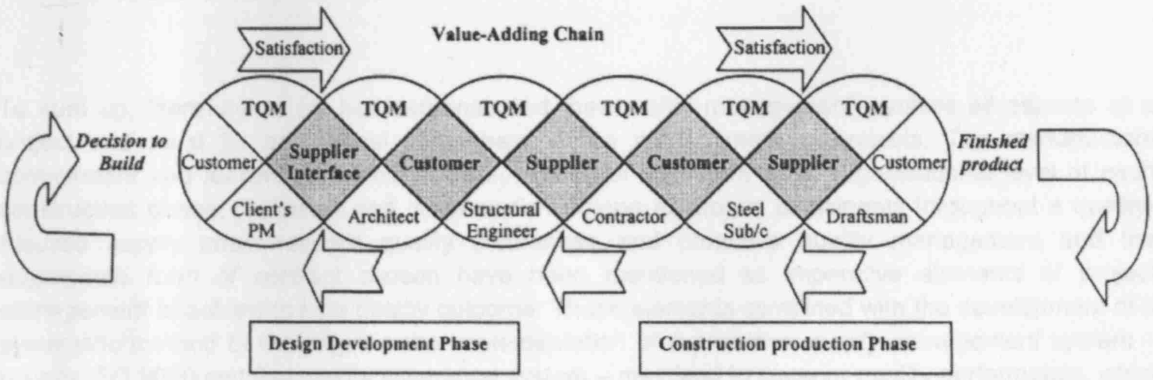


Figure 10: The customer-supplier concept in a construction supply chain (source: Love et al., 2000).

However, in the construction industry, parties working on a project most often treat each other as separate entities and the sense of responsibility for others seems to be lacking (Abdul-Rahman, 1996). Relationships between project teams are mainly contractual, dominated by short-term financial considerations and conflicting objectives. A blame culture is prevalent and mutual trust exists only on a limited scale. As a result quality often suffers. Thus a project-wide involvement by all parties, willing to cooperate towards mutual benefits and with great emphasis on customer – supplier relationships is necessary to resolve any communication problems (Abdul-Rahman, 1996). Initiatives, such as

partnering, aim to align the objectives of the firms involved in the procurement of construction and hence to reduce the difficulties that arise from the fragmentation of the supply chain (Toakley and Marosszeky, 2003). In this way, such strategies promote collaboration and trust as a basis for better coordination and iron out the struggle between the technical interdependence and organisational dependence of contracting firms (Shammas-Toma et al., 1998). Close team-working and synergistic relationships, with the client being part of the team in a genuine partnership, can have a positive effect on meeting the project objectives of cost, time and quality. In this context, a shift from the profession-based scenario, which is highly prevalent in construction, to a project-oriented, team-based scenario can be envisioned (Pheng and Ke-Wei, 1996).

2.6. FORM OF CONTRACT AND THE QUALITY MANAGEMENT ROLE OF THE OWNER

The owner's quality management actions during the construction of the project are defined by the type of contract chosen and are mainly determined by the degree of involvement that the owner is willing to have in the construction process. Nevertheless, whatever the type of contract, the quality issues during a construction project remain the same; the relative responsibilities of the several parties and the balance of risk and liability between them is what actually changes (Ferreira and Rogerson, 1999). But apart from the activities related to the actual construction phase, the owner should have a proactive quality management role at the following stages (Ferreira and Rogerson, 1999):

- *Definition of quality requirements*: stating clearly requirements and expectations to the consultant/ architect saves time and costs in the long-run and reduces the chance for undesirable surprises.

- *Bidding and selection of subcontractor:* ISO certification is not always sufficient as important aspects such as technical capability and ability to deliver work on time are not guaranteed. So owners should assure themselves that the contractor is capable of undertaking the task.

- *Agreement stage*: a quality management plan which addresses the owner's quality requirements and the corresponding duties and responsibilities of either side should be included formally in the contract.

To sum up, literature so far has demonstrated that quality management involves all aspects of a project and must be an integral component in the management of projects. *Top management commitment* and *leadership*, *training* and *education* of staff from every organisational level at each construction phase, *teamwork* and *collaboration* among all project participants throughout a *quality-focused supply chain*, *client*'s quality awareness and proactive quality management and the appropriate *form of contract* chosen have been mentioned as imperative elements of project management in achieving high quality outcome. These elements combined with the development of a systematic method of working, via the implementation of a proactive *quality management system* – usually ISO 9000 certified quality assurance system – may lead to superior quality performance, whist when integrated within a total quality context can pave the way for *continuous improvement* and *business excellence*: the TQM philosophy. This paper aims to replicate these theoretically-grounded findings and delineate some important quality management issues in the construction industry by conducting a survey based on interviews with professionals involved in the design and construction phases of a project.

In order to validate theoretical issues compiled from literature review on themes of quality management in the construction industry *qualitative interviewing* was deployed as the principal research tool. This method was found to be most appropriate for the current survey, because the aim was to get interviewees describe their experiences, opinions and impressions on quality management in their own terms, so as to acquire a clear picture from their perspective on the topic, pursue additional information and expand understanding. *Semi-structured interviews* were conducted on a one-to-one basis with each participant, so as to allow personal contact and stimulate conversation (Creswell, 1994). The interviewee was allowed to talk freely without interruption or intervention and then follow-up questions were raised. *Standardised, open-ended questions* were asked during all interviews, so as to ensure that the same areas of information were collected from each respondent (Valenzuela et al., no date). Each interview lasted approximately one hour and was tape-recorded.

The main limitation of this research method (*personal, semi-structured interviews*) is that it is difficult to secure that the person being interviewed understands and trusts that the responses will be confidential (Sociological Research Skills, no date). Therefore, he may give answers that do not reflect reality, thereby affecting the validity of the survey. The respondent may not consciously lie, but it is quite possible to try to advertise the respective organisation, by highlighting its strengths and concealing its weaknesses.

The primary purpose of this survey was to identify the steps taken by firms within the construction sector to ensure quality during project procurement. In this direction, the interviews were focused on the five key elements identified in the literature as playing a vital role in the effective quality management of a project from inception to completion: (1) the quality management system established by each firm; (2) the role of clients and contracts; (3) the importance of people with regard to quality awareness and training; (4) assessing quality performance in terms of costs and finally (5) the function of relationships amongst project participants. Hence, the research questions (*Appendix*) were categorized under the following subtopics:

- General: a set of questions to understand how quality practices are being applied by the respective organisations;
- Feedback: a set of questions to investigate if and how each firm's quality management system in operation aims at preventing quality deficiencies from occurring in the first place;
- Clients and contracts: a set of questions to examine how the clients' procurement policies affect the company's tendering approach with respect to its commitment to quality;
- Training: a set of questions to discover how important is training and education in the management of quality in general and for the organisations interviewed, in particular;
- Cost of quality: a set of questions to find out what are the costs and benefits of investing in quality in relation with each firm's established quality system;
- Teamwork and collaboration: a set of questions to explore the effect of the entire construction supply chain on the achievement of project quality.

The survey sample consisted of professional engineers involved in the design and construction phases. More specifically, two *case studies* were conducted, comprising a design and consulting engineering firm and a building construction firm, both operating in Greece. Two chief executives (engineers) and a civil (structural) engineer were interviewed from the former company, while a civil

and a mechanical engineer ware interviewed from the latter, which were both managing on-site construction also. The primary *selection criterion* of the companies sampled was the implementation of a quality management system, not necessarily one complying with ISO standards. The design and the construction engineering firms were considered to be a quite representative sample of the construction supply chain, since the most significant quality decisions and the greatest cost and time savings are made during the planning and design stages, whereas most of the quality management effort occurs during the construction phase of a project (Toakley and Marosszeky, 2003). In other words, the construction phase represents the final step in the construction procurement process, though it is the outcome of the previous stages of analysis, planning and design.

The building construction company selected executes large public and private sector building and infrastructure projects. Until now, the company has been involved in numerous such projects including large-scale buildings, hospitals, sports complexes, airports, retail and branch networks and industrial facilities. Its major clients comprise both large *public organisations* including the "Hellenic Ministry for the Environment, Physical Planning and Public Works", the Secretariat General of Sports, Hellenic Telecommunications Company (OTE), Public Gas Corporation (DEPA), *municipalities*, and *private sector companies* including IASO, Filekpaideftiki Etairia, Hellas online, Siemens, Societe Generale, Vodafone, Wind Hellas, Forthnet. Recently, the company has been listed among the five (5) first Greek construction companies registered in the Athens Stock Exchange in relation to their financial performance. Its headquarters are located in Peania, Attica and apart from its 600 employees, it also maintains an outsource network of skilled professionals to assist in the execution and implementation of projects.

On the other hand, the design and consulting engineering firm is involved mostly in large public sector infrastructure projects. Its basic clients are the "Hellenic Ministry for the Environment, Physical Planning and Public Works", various municipalities and private sector. It designs buildings, bridges, foundations, tunnels and underground works as well as it performs geotechnical investigations. It also offers services for structural repairs and reinforcement, seismic design, environmental impact, industrial energy as well as management, supervision and quality control of construction projects. It is located in Athens, and the majority of its 35 employees are civil engineers and draftspersons.

It should be noted that the objective of the interviews was directed towards understanding the respondents' point of view and generating insights into the concept of quality management as it applies to the construction industry rather than make generalisations. Thus the interviews are by no means conclusive, but the information gained can provide an excellent starting point for further investigation into the topic. The observations from each case study mainly concentrated on areas of quality management in the design and construction phases via the implementation of a quality system. Further research is suggested to examine the concept of 'quality' from the client's, the subcontractor's and the supplier's point of view, if a well-rounded overview of the subject is desirable. Moreover, in future research, it would be interesting to examine organisations that are oriented towards Total Quality Management, operating within a total quality culture and aiming at continuous improvement and increased client satisfaction.

4.1. CASE STUDY 1: DESIGN AND CONSULTING ENGINEERING FIRM

4.1.1. GENERAL

The design and consulting engineering firm has established its own quality management system for assuring quality in the production of the drawings. The procedure starts with the design engineer who after conception and analysis produces the design of the required structure. He then makes a sketch which is given to the draftsman who will make the final drawing. The complete drawing is then returned to the design engineer for corrections and revisions. The drawing must follow precisely the design specifications. The company has established a code of colours that is used in this control: *yellow for conformance/ accepted, red for correction and green for refusal*. Following, the draftsman makes all the necessary corrections and/or revisions noted by the design engineer. This procedure is followed until all the parts of the drawing are marked yellow. Then the drawing is submitted to the general supervisor of the project who checks it for conformance to general requirements such as design specifications in accordance with the general project specifications requested by the client, etc.

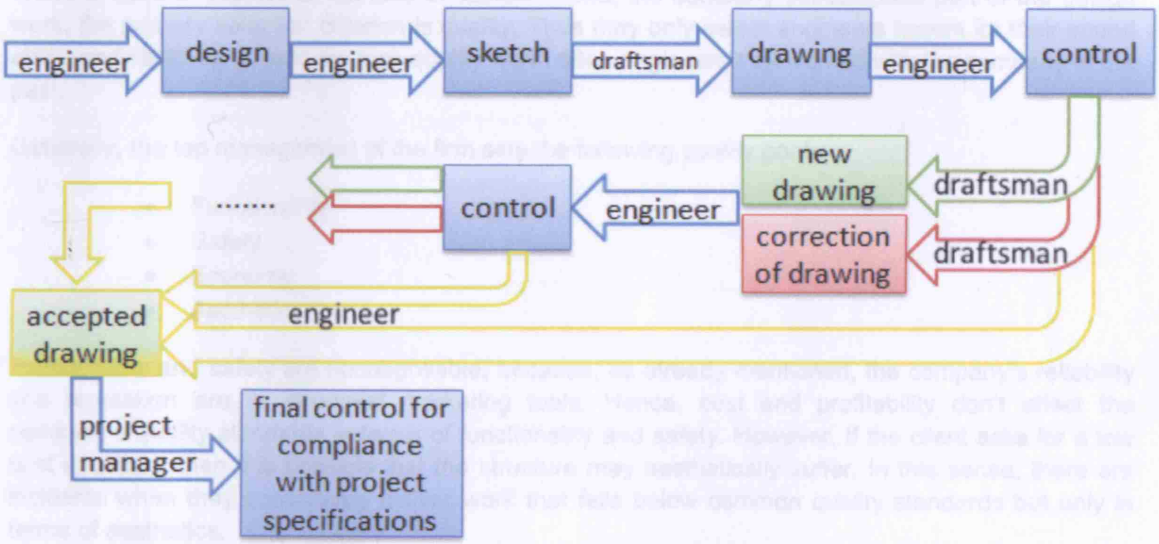


Figure 11: The quality control procedure within the quality management system

This quality control procedure must be strictly followed by all employees – engineers, designers and draftspersons – for all types of drawings and reports that the company produces, even if sometimes it might look a bit monotonous and tiring.

However, the company does not follow any documented procedures for everyday processes. When the company takes on a new project, the top management holds a meeting where it decides the general requirements of the project, such as the disciplines required to carry out the design, the number of people from each discipline, the general directions to be followed etc. Then it selects the project team, which in turn meets and discusses in more detail issues such as applicable laws, regulations, codes and standards as well as design and calculation procedures, etc. Nothing is documented though. When, for example, the manager of each specific project assigns a specific task

to each project team member, there is no formal document signed relative to the responsibilities of each team member.

Although the company has established a quality management system, as described above, it has not been certified by a third party. It is true that the company had previously shown interest to obtain ISO certification as a major client for a public project requested it. However, the chief executives decided that the procedure they had to go through to obtain ISO certification was very much bureaucratic and time wasting. The employees had to spend considerable additional time to fill in the forms at the expense of actual work production. Moreover, after this major client inquired on the quality management system that the company already had in operation, it rendered it satisfactory and so the efforts for complying with ISO standards were abandoned.

All of the personnel interviewed agreed that securing quality in their work plays a vital role. The main reason is the professional responsibility of an engineer when he signs his work. This refers not only to the professional liability laws that every engineer is subject to, but also to the moral responsibility towards the client and the public community. The chief executives stated also that the reputation and the reliability of their firm is another very deciding factor determining the importance of high quality work.

The cost of the quality control procedure followed by the company to assure quality in the drawings production is included in the total cost of the design, although there is no independent project quality plan. It is a standard cost for every project the company undertakes and thus it is always known in advance from the previous projects undertaken.

When in special occasions, ex. lack of sufficient time, the company subcontracts part of the design work, the primary selection criterion is quality. Thus they only select engineers known for their sound ability and reliability to produce high quality work; often engineers that worked with the company in the past.

Generally, the top management of the firm sets the following quality goals:

- Functionality
- Safety
- Economy
- Aesthetics

Functionality and safety are nonnegotiable, because, as already mentioned, the company's reliability and reputation are its strongest marketing tools. Hence, cost and profitability don't affect the company's quality standards in terms of functionality and safety. However, if the client asks for a low cost structure, then it is possible that the structure may aesthetically suffer. In this sense, there are incidents when they consciously deliver work that falls below common quality standards but only in terms of aesthetics.

4.1.2. FEEDBACK

The company keeps an information base where details of all previous design works are stored. When a project team is assigned a new but ordinary project, then it utilises the company's information base to collect data from previous similar works. In this manner serious mistakes are avoided and adherence to the company's technical standards is ensured, the *"technical tradition"*, as the interviewees called it. In this way, the information base helps the engineers identify and avoid potential defects early in the design stage rather than correct them after completion.

The information base is constantly renewed through the company's feedback system. Every time that a team is assigned a new project, there are several alternatives that can be followed as far as the

management of the project and the adoption of technical design methods are concerned. Hence, if a specific alternative meets the quality criteria of functionality, safety, economy and aesthetics better than others, the project manager of that team informs the other project managers involved and also feeds back the information to the company's information base. In this way, this continuous transfer of knowledge and experience among all employees leads to future quality improvements.

However, the company doesn't use any problem solving tools for diagnosing quality errors.

4.1.3. CLIENTS AND CONTRACTS

All respondents (100%) agreed that it is definite true that the procurement policies of many clients are based on low tender price. However, they stated that "*the company never bids for a project based on price and luckily until now we have managed to stay truly committed to quality*". But this is not the case in construction. There are many competitors that have to lower their quality and price standards in order to win contracts. "*The future is uncertain*", said the chief executive.

Clients, on the other hand, don't give sufficient consideration to the quality records of the bidders. Even if sometimes they realise that there would be fewer problems if they had chosen the contractor based on criteria other than price, they still look for the lowest tender price the next time.

4.1.4. TRAINING

Because of the nature of the work, training is regarded as a vital factor in the company. Of course, the technical background of all the engineers is of essential importance. As far as the draftsmen are concerned, the company offers additional training in technical issues. Moreover, the company pays great attention to the upgrading of knowledge. Thus, it has established a series of weekly seminars and workshops for the engineers and the draftsmen on Fridays in the company's seminar room. These seminars include the presentation of new design methods, of issues discussed in engineering symposiums or of works of specific interest. Apart from the internal seminars, the company also gives the opportunity to the engineers to attend domestic and international engineering symposiums. Hence, it is obvious that the company faces the education and training of its employees in an academic way. Nevertheless, quality is not treated as a separate training subject and "*quality awareness arises from high professional expertise*", one could say.

4.1.5. COST OF QUALITY

In terms of the cost of quality, the chief executives stated that they never negotiate the good quality of the design even at the expense of profit. Yet only in an "*ideal world*" do contractors who invest in measures to achieve high quality work increase their chances of winning contracts.

The quality management system that they have established, although it has low cost of operation, has helped the company minimise the costs of deviation. There were few incidents when the drawings were returned for corrections and even in those cases the mistakes were so minor that they didn't have to make the design from the beginning. So the costs didn't rise.

4.1.6. TEAMWORK AND COLLABORATION

All respondents (100%) agreed that the problem of teamwork and collaboration in the construction industry exists without doubt. In order to deal with it and minimize conflict in the project coalition, the company asks for the appointment of a project manager – either internal or external – whenever this is feasible and commonly acceptable. In this way better co-ordination among all parties is achieved and it becomes more difficult to switch the blame.

The project quality is everyone's responsibility and who will be responsible for quality control mostly depends on the project. The client plays an important role but he does not determine the final quality. That's because the designer and the rest of the project coalition have the moral responsibility to deliver high quality work even if the client doesn't possess the appropriate knowledge and experience to evaluate it correctly. It is immoral to "*steal the client's acceptance*", said the chief executive.

4.2. CASE STUDY 2: BUILDING CONSTRUCTION FIRM

4.2.1. GENERAL

The building construction company practices quality management through the implementation of a quality system which is developed to comply with the ISO 9000 series of standards. In particular, the quality system conforms to ISO 9002 as the company works with the design supplied by the engineer/ architect but does not undertake design-and-build contracts.

The quality system is fully documented and readily available in the workplace. Figure 12 depicts the four tier documentation that the firm's quality assurance system is comprised of. The firm's quality policies as well as the quality system's requirements stipulated in ISO 9002 are included in the quality manual.

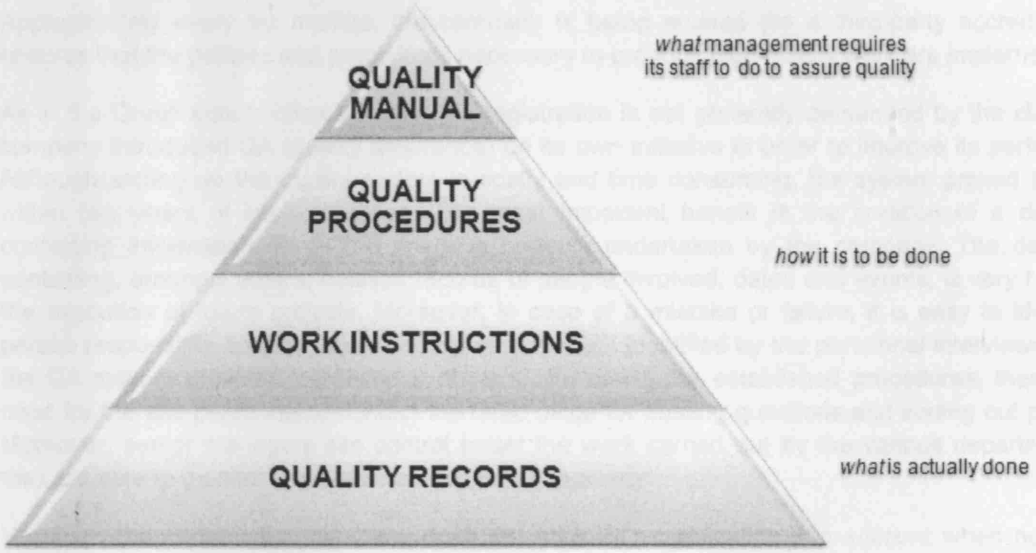


Figure 12: The hierarchy of the quality system documents (source: adjusted from Chung, 1999).

On a project basis, the quality system is implemented through the project quality plan (Figure 13). The quality plan is a document which sets out the specific quality requirements of the project in question; it can be characterised as the quality manual of the project.

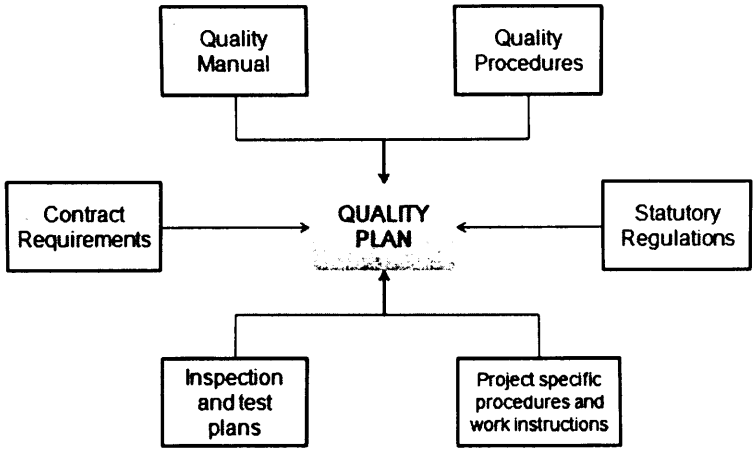


Figure 13 Contents of the quality plan (source: Chung, 1996).

Approximately every six months, the company is being audited (by a third-party accreditor) who ensures that the policies and procedures necessary to produce high quality work are implemented.

As in the Greek construction industry ISO registration is not generally demanded by the clients, the company introduced QA (quality assurance) on its own initiative in order to improve its performance. Although setting up the quality system is costly and time consuming, the system proved beneficial within two years of implementation. The most important benefit is the creation of a data base containing information on all the previous projects undertaken by the company. The data base, containing, amongst others, detailed records of people involved, dates and events, is very helpful for the execution of future projects. Moreover, in case of a mistake or failure, it is easy to identify the person responsible and task executed. Another benefit identified by the personnel interviewed is that the QA system provides 'consistency of work'. Following the established procedures, there is less need for the site personnel to contact the head office for posting questions and sorting out problems. Moreover, senior managers can control better the work carried out by the various departments, as they are able to monitor the system's documents regularly.

However, the construction company does not take ISO certification into account when nominating suppliers and subcontractors. The following quote by the construction engineer reflects the Greek reality: "*quality management in the Greek construction market is still at an infancy level; there are no more than 3-5% of the contracting and sub-contracting companies implementing a formal system of QA, such as ISO 9000*". For this reason, the company selects its suppliers and subcontractors based on criteria such as organisation and/or past experience with the supplier/subcontractor so as to be confident of his technical capability and financial capacity to carry out the assigned work.

There are several external factors inhibiting the achievement of high quality standards during the construction phase. One major problem is the absence of quality focus of the suppliers and subcontractors. Since they rarely have a quality management system in operation, contractors often face undesirable surprises. To eliminate this problem, the contractor must put his own staff on site to supervise/ police the subcontractor's work, which, of course, is an additional cost in terms of time and money. One engineer contrasted the Greek material suppliers with those from abroad: "*our foreign suppliers are all certified with ISO and you can see the difference: their websites are well organised, presenting analytically all their products; you can make the order online and if you want you can visit other construction sites to see their work. You know from the beginning that what you see is what you get. This is absolutely not the case in Greece*".

Another detrimental factor is some clients' misconception that the contractor's QA system is "*a magic cure*" for all construction problems. They believe that once the system is in place, construction will be

free of non-conformance, so they start pressing for shorter construction duration, even if they don't have any particular reason to be rushed. These pressures often favour speed at the expense of quality.

Moreover, inflation and unstable market conditions also have a negative impact on the project quality. In most cases, the lead-in time between tendering and beginning of construction is more than one year, thus it is quite possible that prises rise in the meantime. One the one hand, the client is reluctant to pay more than agreed in the contract, but on the other hand "*construction companies are not charitable institutions*", as the construction engineer said. Consequently, the contractor searches for cheaper materials, which most probable will be of lower quality too, in order to remain within budget.

All respondents (100%) stated that cost and profitability do not affect the company's commitment to quality. "*It's all about accurate work organising and planning*". If, for example, the required amount of construction materials is ordered in advance and kept in stock until construction is due to commence, the contractor will not be confronted with unexpected price increases. Also, the implementation of the quality system has contributed significantly to consistently meeting the project's specifications and reaching the quality goals. By implementing systematic updating of the data base, the contractor is constantly kept informed of the construction materials prices all over Greece. "*There have been incidents that it was cheaper and faster to buy materials of same quality from remote cities, when, for example, there is low demand in those cities. Due to ISO we're experiencing benefits that we hadn't even imagined*", said the mechanical engineer.

Although the construction company under review has a certified quality system in operation, there have been incidents when the quality achieved fell below the required standards, mainly due to the technical inability of the selected subcontractor. In such cases, the contractor immediately takes corrective actions before handover, but often there are strict time constraints which inhibit the complete restoration of deficiencies.

According to the contractor, the subcontractors and the designers are primarily accountable for defects arising in the construction phase. On the one hand, it is not uncommon that subcontractors try to deceive contractors in order to gain higher profits by using cheaper materials of lower quality, not following the project's specifications and by employing unskilled, migrant labour. Although, the contractor's staff supervises and checks the subcontractor's work on a regular basis, it is often difficult to recognise and prevent all potential deceptions, as it is obviously impossible to be fully familiar with every subcontractor's work. "*The subcontractor knows well how to deceive you*", said the engineer. On the other hand, the absence of designers from the construction site and poor responsiveness on required information also have adverse effects on the project's quality. In many cases, designers are indifferent to the construction of the project, due to low design fees or because they are occupied with other projects undertaken simultaneously. Hence, contractors and subcontractors, who heavily rely on the designers' information, are left to deal with any inconsistencies between the drawings and specifications. Apart from that, without the designers' close supervision and control to ensure that the design quality goals will be achieved, they don't have any real incentive to promote any quality improvements on site.

4.2.2. FEEDBACK

Within the QA system a data collection system is established in order to build an information base that can lead to early identification of defects. Any defect that occurs during construction is recorded by the person in charge and fed back to the system. Immediately, a notification is mailed to all those who are affected, while at the same time a new work instruction will be added to the system so as to prevent the defect from reoccurring during the following projects. By inputting new information the quality system is constantly amended and work procedures are changed when necessary thereby facilitating '*doing it right first time*'.

4.2.3. CLIENTS AND CONTRACTS

Although most clients' procurement policies in Greece are based on low tender price, the interviewees stated that this does not obstruct their true quality commitment. Again here, "*everything depends on detailed organising and pre-planning of the work; then it is quite possible to offer the lowest price with better quality as well*". When bidding for a project, the construction firm calculates the tender price based on the budget of previous similar projects undertaken. All the necessary information is found in the company's quality system database. "*Under no circumstances will we submit a lower tender than is actually calculated in order to win the contract*", claimed the engineer.

On the other hand, clients award the contract to the lowest bidder anyway. Quality is of secondary concern. If one of the bidders has a quality system in operation they will ask him to lower his tender price in order to be selected. But in general, most construction clients in Greece have underestimated their role in the management of quality. As far as they don't make the implementation of a quality system a contractual requirement, the few contracting firms that have invested in it for their own benefit can perfectly use it as a strong marketing tool.

4.2.4. TRAINING

The construction firm regards training and quality awareness of all employees – from managers to field labour – very important not only when the quality system is first implemented but also after the system is in full operation. In the construction manager's view, the training of employees is highly important in the construction phase, whilst in the design and the operation phases not so much. At short intervals, internal site meetings are held but there is no specific training plan followed.

4.2.5. COST OF QUALITY

The initial cost associated with setting up the quality system (cost of prevention) and obtaining ISO (third-party) certification was huge for the construction company. Much time and expenses were dedicated to train the staff and familiarise with the new procedures. Moreover the firm needed to create a new department and employ ten quality assurance managers only responsible for monitoring and controlling quality. But once the system is fully in operation and the data base is filled with information, '*it pays you back*'. The construction engineer encapsulated the advantages of the quality system in the following metaphor: "*investing in a QA system is like buying a computer; it costs and you have to learn how to use it. But time and effort spent in the beginning are more than recovered when you become fully acquainted with it*".

The interviewees believe that contractors who invest in a quality management system increase their chances of winning contracts, provided that they do not raise their prices because of that. "*It is not an excuse to charge higher fees because you have gained ISO registration*". If an ISO certified contractor submits an expensive tender, it is more cost effective for the client to award the contract to a lower bidder and then employ his own project manager to supervise the work. Or, the client will select the certified bidder but will negotiate for a lower bid before awarding the contract.

The cost of appraisal (quality control of materials) is unavoidable and occurs irrespectively of the quality management system in place. This cost is included in the tendering price and is estimated as percentage of the project budget (~1%) based on previous projects (from the ISO information base).

The cost of prevention is difficult to be totally eradicated but, due to its quality system, the construction company has managed to keep it to a minimum (1-2% of the project budget).

4.2.6. TEAMWORK AND COLLABORATION

The engineers highlighted the significance of teamwork and collaboration among all parties for achieving the quality goals of the design. Although the different disciplines do not possess the technical knowledge required to provide sound guidance on technical issues to each other, they can still provide useful advice and help as '*outside viewers*'. "*The mechanical engineer has repeatedly in the past sparked off a solution to a problem that I couldn't see; he can also save me from a lot of trouble because he may see a defect that I didn't notice and so I'll fix it before the client notices it first*", pointed out the construction engineer. "*Teamwork is the number one key to quality*".

According to the contractor, the designer/ architect who has set the project's specifications and the quality goals of the design is actually responsible for quality control during the project and for the final project outcome. If the contract does not call for the designer as general supervisor of the project, then the client has to appoint a project manager/ consultant to be responsible for project quality. However, "*it's surely not the contractor's responsibility. Our company does it anyway because it has its own quality management system in operation, but other contractors will tell you that's not my job, call the designer*".

5.1. GENERAL

The fact that both firms have established and implemented a quality management system indicates that quality is a major objective for both of them. The difference in the approach taken to achieve quality between the traditional (design firm) and the quality certified company (building contractors) lies in the use of formal procedures of the latter (Abdul-Rahman, 1996). On the one hand, the design firm has launched standard procedures and work instructions that cover all routine operations in order to ensure quality in the design phase. These can be simply called 'standard management procedures' (McCabe, 1998). For the design firm, strict adherence to the design office codes of practice and checks by qualified engineers are integral parts of their quality system. However, the design firm neither formally records every procedure nor carries out internal and external quality audits. The system is only internally assessed (first-party assessment) and not according to any widely accepted standards. On the contrary, the building construction firm relies on the use of formal procedures and audits and utilises standard forms for reporting to ensure compliance to specifications and drawings. Moreover, it has gone through third-party assessment and is certified for complying with ISO 9000 series of standards, thus it is actually practicing quality assurance. This is the major difference between the two firms. Verification, or reporting of what is actually done, is the point where QA departs from merely having standard management procedures (McCabe, 1998).

However, any procedure that is not formally documented and assessed but contributes towards improved performance should not be disregarded. As Brown (1993, sited in McCabe, 1998) supports: "*a system is whatever works for your organisation in order to process work smoothly and effectively from start to finish. The best system is one that has been proved to work*". This statement describes the case of the design firm: top management, although initially showed some interest to introduce an ISO quality system, realised that the firm could still experience the same benefits with its current quality system in place. Moreover, after being assessed by the client (second-party assessment), the existing system was found to be sufficient and satisfactory. Thus efforts to achieve certification were ultimately abandoned. The reason that senior managers of the design firm did not eventually see the benefits associated with an ISO certified quality system, is likely to be that the initiative to introduce a formal system of QA was client-led and hence was treated as an additional operational routine; an unnecessary and expensive distraction. On the other hand, it is also quite possible that a formal QA system proved to be inappropriate for the design firm, not due to lack of genuine top management commitment, but because, as claimed by Gnome (1995, sited in Love et al., 2000), ISO 9000

requirements are far too sophisticated and do not add value to small and medium-sized organisations. This is mainly due to the initial high costs involved and increased paperwork associated with achieving and maintaining registration which can be damaging for a small/medium size business.

Both firms are experiencing similar benefits from the implementation of their respective quality system. Improvements in efficiency and business performance and consistency of work are common advantages. Also, both firms have set up data bases. Such data bases contain information of all previous works undertaken and are being constantly updated through feedback procedures. This contributes to the early identification of defects during design or construction respectively and facilitates quality improvement. However, the building contractor experiences further benefits from practicing QA. By keeping detailed records, it is easier to allocate responsibility in case of a mistake, and top management can gain better overall control. Moreover, adherence to the internationally accepted ISO standards often serves as a useful marketing tool.

Although both the design and the building contracting firms have a quality management system in place, this does not seem to be the general case in the Greek construction industry. Clients have not made it mandatory for tendering contractors and subcontractors to implement a QA/ QM system, hence only a small percentage of Greek firms are certified with ISO 9000. This indicates that the recognition of the benefits resulting from application of quality assurance is still lacking. As a result, the design and building contracting firms interviewed nominate suppliers and subcontractors primarily on the basis of confidence due to past experience with them. Contractors evaluate subcontractors according to their labour and plant resources as well as their financial standing, while designers seem to value more their subcontractors' track records. But these evaluation measures are obviously not always adequate. The absence of implementation of an effective quality management system in general and of ISO certification in particular is the basic cause of non-conformance incidents, reported especially by construction managers. More specifically, the subcontractors' professional incompetence and the unqualified foremen and workers employed on the site are identified as the root causes for rework during construction. Subsequently, the list of acceptable subcontractors and suppliers cannot be totally reliable and must be constantly updated, as there is no objective proof of their skills and ability to provide the end product on site in accordance with design and specifications. So the contractor, who ultimately retains main responsibility for delivering quality work, is not protected from undesirable surprises and disappointment. It is worth noticing, that the design firm interviewed did not report any incidents for cases where the quality achieved fell below the required standards. This could be explained by the fact that the design firm subcontracts only a small amount of work to other subcontractors (engineers) and only on special occasions, whilst the building contractors are highly dependent on their subcontractors and suppliers, as they are those who carry out the actual on-site work.

An important deduction that comes to light from the interviews is that the fragmentation of the supply chain in Greece is destructive to project-wide commitment to quality. The absence of quality focus of the suppliers and subcontractors as well as the clients' misunderstanding of the actual meaning of quality management are the major obstacles to the implementation of a quality system on site. Due to this lack of understanding, they cannot see personal benefits in a quality system, thus they are reluctant to change behaviour and attitude (Abdul-Rahman, 1996). The lack of quality focus also leads to lack of supplier-customer focus, where suppliers in the construction supply chain do not value their customers, i.e. they do not see the customer as the focus of their activity. As a result, subcontractors try to find shortcuts to exploit the contractor's QA system, while designers use low design fees or increased workload as excuses for providing poor service. Ultimately, as the parties involved in the project do not carry out their duties properly neither they aim at the achievement of shared goals, the project quality outcome is adversely affected.

It is worth wondering why both the engineering design and the building construction firms, as claimed, stay truly committed to quality although operating in such a volatile and hostile environment where

most firms are concerned with increased profitability and most clients' procurement policies are based on low tender price. Of course, they are concerned with reducing costs and increasing profit margins. Yet, all people interviewed vehemently condemned negotiating quality even at the expense of profit. Two are the logical explanations here: firstly the professional responsibility of each firm's employees restrains them from consciously delivering quality below required standards; secondly, the quality system that each firm has in operation enables them to successfully complete high quality projects at affordable prices. The application of standard systems and procedures, as well as the additional time and effort spent on planning and prevention of non-conformance, as opposed to the traditional 'firefighting' approach prevailing in the construction industry, have constituted the key factors for both firms to remain committed to quality.

5.2. CLIENTS AND CONTRACTS

As far as construction clients are concerned, it is obvious that they adopt a narrow view of the relationship with contractors and designers. They select on price and expect their interests to be protected through contractual provisions (Shammas-Toma, 1998). But where time and money are at a premium, the introduction of quality is doubly difficult. Thus, the 'cheapest' selection criterion is not appropriate when time, budget and quality requirements are equally important, as, inevitably, completing the works on schedule and controlling the costs to within budget are mostly achieved at the expense of quality (Abdul-Rahman, 1996). The selection of the 'cheapest' tender should only be preferred when quality is of secondary importance. Apart from that, for quality management in construction projects to be effective, Greek clients must initiate its implementation. Although it seems that they have not yet realised the major influence that quality management may have on project quality, or perhaps they do not care enough, it is absolutely necessary that pressure for change and improved quality in the entire construction industry should come from well-informed clients, amongst others. In this direction, clients should start taking a holistic view over the construction quality process and nurture a much closer liaison with contractors (Shammas-Toma, 1998).

5.3. TRAINING

Training, as an ongoing process, and quality awareness were identified by both companies as playing a significant role in achieving and maintaining high quality standards. Even though the building contractors regarded training in the construction phase to be more important than in the design and operation phases, training efforts appear to be more intense in the design firm. The fact that the design engineers treat training more seriously than the construction managers is largely relevant with the different strategic directions followed by the two firms. On one hand, the design firm focuses on delivering higher-value services, thus managers are more concerned with developing the skills and abilities of the employees that will ultimately lead to improvement and innovation. Through innovation, the top management of the design firm is seeking to achieve service differentiation, thereby responding to its low-cost rivals. Conversely, the construction organisation is dependent to a large extent on labour-based engineering operations that are easily undercut in price. For this reason, construction managers are more concerned to complete the project on time, in budget and to specifications in order to achieve service differentiation. In this direction, poor training is often condoned to keep up with expected productivity and meet the final goals.

5.4. COST OF QUALITY

The building construction firm has invested a large sum of money in setting up the quality system and obtaining ISO certification. Nevertheless, after operating the system for a few months, the firm was recompensed; their initial investment in prevention resulted into reducing the costs of deviation by half. On the other side, the design firm dedicated significantly less expenditures for their quality system, as it saved the registration, consultancy and auditing fees, which are necessary for achieving

and maintaining ISO registration. However, since the company does not formally document procedures and does not keep detailed quality records, the costs of establishing and implementing the quality system are unspecified. Apart from that, as already explained in the literature, it is difficult to identify prevention costs in such cases, as in fact many quality and non quality activities are directed at the avoidance of quality problems.

In general, the success of both businesses in achieving quality through the implementation of a proactive quality system proves that the belief about quality as being an expensive venture is totally mistaken. Especially in the case of the construction firm, it is demonstrated that the costs incurred in prevention are minimal when compared to the costs of rework, scrap material and lost time.

However, there are divergent views on the benefits that the two firms are experiencing outside the organisation from investing in quality. The employees of the design engineering firm stated that only in an ideal world would their efforts for high quality management be rewarded, while those of the construction firm disagreed. This contradiction has a reasonable explanation. The designers cannot see the benefits that the construction engineers do, because, although within the organisation the quality system is an effective management tool, the design firm is not certified by a third party. As a result, the system do not serves as a marketing tool as well. On the contrary, the building contractors can use their quality system as an objective demonstration of their ability to produce work in a cost effective way to meet the customer's requirements (Chung, 1999). In this way, they can expand their business opportunities and increase their market share. Hence, it is evident that reputation and reliability in Greece are not as strong marketing tools as having gained ISO certification.

5.5. TEAMWORK AND COLLABORATION

Although the people interviewed agreed that, during the execution of a project, teamwork among all parties is essential to attain the quality goals of the design, it appears that they treat the achievement of quality outside their respective organisations, not as a function of relationships, but as a matter of strict adherence to calculated and specified requirements. The fact that the design firm asks for third-party intervention in order to reduce conflict and achieve better coordination, reveals that little cooperation exists towards mutual goals and obviously there is no 'room' for trust within the project coalition. Similarly, the construction firm, although it has established a formal system of quality assurance, exploits it better as a marketing tool rather than to promote collaboration and trust. This attitude, of course, inhibits any further quality improvements beyond just meeting specifications.

Moreover, an abrogation of responsibility in coordinating efforts towards project quality outcome seems to be apparent, in particular by the building contractors, as they consider it as the responsibility of either the project manager or the consultant, depending on the project delivery system in use. Generally, this arrogance of firms in pursuing only their own objectives forms a barrier to the formation of good working relationships (Love et al., 2000).

There is great potential for quality improvements in the construction industry. There is not much time nor resources to waste (Arditi and Gunaydin, 1997). Thus construction companies must focus their activities on improving the overall project performance and attaining high quality standards. Adoption of the TQM philosophy serves great for this purpose. However, it is suggested that initially, firms have to establish and implement a quality management system in order to lay the foundations for a quality culture.

Project managers and company administrators should consider the following points in developing their quality systems:

- Undertaking measures to achieve high quality initially costs. However, the *cost of quality* should not be considered an expense but an investment (Arditi and Gunaydin, 1997). By taking up a proactive role based on a "preventive philosophy", firms can achieve great cost savings on total costs of design/ construction through eliminating rework and wasted work (Pheng and Ke-Wei, 1996). In the benefit assessment of higher levels of quality, non-quantifiable aspects of quality should also be included, such as improved client satisfaction, 'value creation', reputation and increase in business opportunities (Toakley and Marosszeky, 2003; Love et al., 2000).

- *Top management commitment* to quality is crucial in each phase of the project procurement. If any quality initiative is to succeed, management must initially invest significant amount of money, time and effort in order to generate enthusiasm and convince people who actually carry out operations to 'buy in'. Following that, clear goals, an organic organisational structure and open communications lead to quick adherence to advanced 'quality procedures' and increase the effectiveness of operations. *Quality awareness and training* at all levels (management as well as operative levels) and in all phases (design, construction and operation phases) actively supported by top management are essential to reach superior quality performance (Arditi and Gunaydin, 1997).

- The whole construction industry is project-oriented so improved quality performance must be *project-related* thus include the whole project team and above all the client. Each and every firm in the supply chain must realise that improving quality is not a one-sided process. At some point, the project participants are both a customer and a supplier and they have a significant role to play not only to the project outcome, but also to the business success of others. Hence, the concept of 'quality' should be addressed both at the organisational level and at the customer-supplier interface (Love et al., 2000). Any quality improvement effort should incorporate the integrated quality management activities of all members in the construction supply chain. Initiatives, such as partnering arrangements, contribute to the creation of a *teamwork* spirit, promote *collaboration* as a basis for better *coordination* and ultimately enhance final quality.

- The *form of contract* chosen in a project defines legally the authority, responsibility and accountability of the various project participants and the quality system must, as a matter of practice, have regard to these legal implications (Pheng and Ke-Wei, 1996). The type of contract used depends on the client's experience and knowledge of construction projects and his ability and willingness to take an active role. However, in all types of contract, the *client commitment* to quality is of paramount importance. To secure quality throughout the entire process, the client has to demonstrate active interest, by removing any barriers inherent in his

procurement policy to ensure that nothing blocks progress and, in many cases, exert pressures to contractors and designers for improved quality outcome.

The two case studies, involving a design and a construction engineering firm, shed light to the quality management practices adopted by design and construction firms in order to achieve quality in the project outcome. The two firms investigated have both designed and established a prevention-oriented *quality management system* and experience similar benefits: improved efficiency and business performance, consistency of work, reputation and reliability. Due to the operation of their respective quality systems, cost and profitability do not affect either firm's *commitment to quality*, while they are neither affected by the *clients'* 'price-based' instead of 'quality-based' procurement policies. Moreover, the construction managers' assertion that, although the huge initial investment, the quality system has paid them back verifies theoretical findings that *quality does not cost, it pays.*

However, the study revealed some serious problems in quality management mainly occurring due to the fragmentation of the construction supply chain. The subcontractors' and suppliers' absence of quality focus, the designers' indifference towards reaching the quality goals of the design during the construction phase and the contractors' abrogation of responsibility for the final project quality inhibit the formation of good working relationships, holding all of them responsible for quality defects on site and poor project performance. Although both firms recognised the importance of *teamwork* and *collaboration* throughout the supply chain, conflicting priorities between the project participants allow 'little room' for *cooperation* and *coordination* towards mutual goals. Formal contracts govern the relationships between the parties as contracts are mainly relied upon reducing conflicts and resolving disputes.

In order to sort out these problems and develop a quality culture in construction, the general contractor should demonstrate a top-down commitment to quality management and create a conductive work environment. In the light of improving project quality performance, the general contractor should develop an enabling structure and efficient communication system for effective relationship management integrated within the project management context (Wong and Fung, 1999). Moreover, education and training in the importance of quality generally and in QA/QM specifically should be extended at least to the foreman hierarchy before any substantial improvement in the management of quality can be achieved (Abdul-Rahman, 1996). Clients should end the practice of awarding contracts on the basis of price tag alone if superior quality performance is desirable. According to Arditi and Gunaydin (1997), successful projects in the future are likely to be assessed based on quality, life-cycle costs and supplier responsiveness, which can only be achieved through partnering arrangements. In this direction, clients and the rest project coalition should unlearn the 'habits' of competitive tendering (Shammas-Toma et al., 1998), release any short-term financial considerations and take a holistic view over the quality process in order to generate a mutually rewarding scenario for everyone. If all parties in the construction industry jointly aim at the achievement of shared, high quality goals, then significant quality improvements on a regular, never-ending basis may be attained.

However, apart from fragmentation of supply chain and absence of project-wide commitment to quality, this survey identified a more serious problem in the Greek contracting firms: even though both companies interviewed have a quality system in operation, neither of them has adopted a continuous improvement orientation; they are both far from being devoted to the TQM philosophy. It is evident that each respective quality system serves as an internal management tool for improving the companies' performance and the internal operations efficiency, but the system is not integrated with all other aspects of work and mainly on-site work. Neither firm has recognised the integrated and interdependent nature of the project system and its parts (Pheng and Ke-Wei, 1996). As a result, there is no indication of any project-related improvement of quality performance, while the aims and goals of both firms remain still result-oriented and not process-oriented (Pheng and Ke-Wei, 1996). It

could be said that construction firms in Greece are not proactive enough to sense and be prepared for future change; they are responding reactively to the increasing demands of the clients.

This case study research has its limitations in only investigating quality management by virtue of a quality management system from the perspective of two companies exclusively: one design and one construction engineering firm. Further research in the topic should incorporate the role, opinions and behaviours of suppliers, subcontractors and clients so as to gain an in-depth understanding in the quality management practices of all actors throughout the construction supply chain. It is also necessary to examine the actions performed by TQM oriented firms, so as to be able to make clear comparisons between various quality management approaches.

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QUESTIONNAIRE

GENERAL

1) Has your organization established a quality management system?
   a) If yes, is your company registered as complying with ISO standards (third party certification)?
2) Do you follow documented procedures for the various processes carried out by your company?
   a) Do you have a quality policy which informs your staff what top management requires them to do to assure quality how this is to be done?
3) What was the purpose for starting practicing quality assurance? (reputation/ marketing necessity, improving efficiency, partners' and clients' requirements etc.)
   a) What benefits do you experience from QA?
4) Do you prepare a project quality plan before construction is due to commence?
   a) If yes, do you assign appropriate costs to these procedures when bidding for a project?
   b) Do you take quality planning into consideration in such activities as nomination of subcontractors and suppliers, construction programming, identification of manpower requirements, material and plant acquisition etc.?
5) Which external constraints of the competitive market that the construction industry is subjected to, do you think that are detrimental to the achievement of satisfactory quality standards?
   a) Which of them fall outside your company's control? (for instance: client wanting cheaper faster products)
   b) To what extent do cost and profitability affect your commitment to quality?
6) Are there any incidents when quality achieved fell below the required standards? (despite the fact that the company involved had quality control procedures in operation)
   a) If yes, what were the reasons for that and how was that dealt from your company?
   b) What do you think are the most common quality defects arising in construction and whose responsibility is this?

FEEDBACK

"QA is oriented towards prevention of quality deficiencies. It aims at minimizing the risk of making mistakes in the first place, thereby avoiding the necessity for rework, repair or reject."

1) What measures does your company take in order to prevent rather than detect defects after completion through checking?
   a) For example do you use an information base that can lead to early identification of defects?
2) Does your company have a feedback system for re-examining quality control work? Do you have any specific quality criteria against which improvements can be monitored?
3) Do you think that problem solving tools such as statistical methods are helpful in diagnosing quality errors correctly? Does your company use such tools?

CLIENTS AND CONTRACTS

"It is true that many clients' procurement policies are based on low tender price".

1) Do you think that this "obstructs the way" for real quality commitment from both the contractor and the clients'?
2) Is sufficient consideration given by clients to the qualification or quality records of the bidders?

TRAINING

1) Do you regard quality awareness and training as important factors through which the workforce could control quality and identify sources of problems more efficiently?
2) In which phase (design, construction, operation) do you think that such training is important and who do you think should be the main recipient of training efforts (i.e. managers, engineers, technicians, field labour, etc.)? Why?
3) Do you provide your employees with such training?

COST OF QUALITY

1) What do you think that are the advantages and disadvantages of investing in quality in terms of costs?
2) Do you think that contractors who invest in measures to achieve high quality work increase their chances of winning contracts?
3) What do you think that are the economic benefits of a proactive quality system regarding the costs of prevention, the costs of appraisal and the costs of deviation?

TEAMWORK AND COLLABORATION

"*Teamwork among all parties (structural, electrical, environmental, civil eng., architects and owners) is essential to reach the quality goals of design. However, relationships in construction are frequently antagonistic and a blame culture – far from being devoted to quality improvement and dominated by short-term financial considerations – is common.*"

1) What is your opinion about this issue, what situation does better reflect reality and how does your company deal with it?
2) Who is actually responsible for project quality/ quality control during a project? (i.e. client, consultant-architect, contractor, depend on the project etc.)