Journal of Applied Sciences

ISSN 1812-5654

science alert

ANSInet
an open access publisher
http://ansinet.com

Journal of Applied Sciences 9 (15): 2778-2785, 2009
ISSN 1812-5654

Study on the Concept of Quality in Construction Works

[1]R. Giuşcă, [2]V. Corobceanu and [3]M.C. Nenov
[1]Department of Concrete Structures, Building Materials, Technology and Management,
Faculty of Civil Engineering and Building Services Iasi, Romania
[2]Faculty of Civil Engineering and Building Services Iasi, Romania
[3]Department of Materials, Technology and Management,
Faculty of Civil Engineering and Building Services,
43 Dimitrie Mangeron Blvd., Iasi, 700050, Romania, Iasi 700050, Romania

Abstract: The aim of the study was to show new approach regarding the implementation of new technological changes for the construction works quality perception. Although, the European economic environment is not yet characterized by a real free market, the actions of the contemporary market determine specific behaviour of the organisations with the prevalence of competition for resources and customers where quality plays an important part. The interest for these systems is transferred from the production sector to services and educational system. Still, the design and organization of quality management systems first imply the definition of quality. Quality, as well as freedom or justice, is a rather difficult concept to define since it has a high degree of relativity. The evolution of society determined the personalization of the way the concept of quality is perceived. Every individual has an instinctive understanding of what quality means, whereas the perceptions are definitely different. The researchers show these fundamental perceptions of quality and tried to decrease the subjective idea that quality is associated with the idea of good and is therefore used to justify or validate an activity or object without paying much attention to the exact meaning of the word.

Key words: Product, quality, performance, conformity, durability

INTRODUCTION

The traditional concept of quality is associated to the existence of a product or service that is distinctive and special, investing the owner or the user with a certain superior statute. There are high standards of production, delivery and presentation that can be reached only with great expenses and are not accessible to all users/consumers. Such an approach of quality implies the notion of exclusiveness. Considering a different approach, quality is defined as conformity to certain stipulations or standards, based on the notion of quality control applicable to the productive segment. In this context, the standard term is used to describe a characteristic required from a certain product or service. The stipulations of a product include a certain number of standards. The quality of products or services refers to tests conducted in order to find out if they satisfy the required standards.

Speciality dictionaries mainly provide two types of definitions of quality that are important in the analysed field. These definitions are based either on the relationship between the product's quality and characteristics or on the relationship between quality and the lack of deficiencies.

The characteristics of a product have a direct impact on the production costs, meaning that, from this point of view, a higher quality usually implies higher costs.

On the other hand, the deficiencies of a product also have a direct impact on the costs, so that, from this point of view, a higher quality usually costs less.

It is therefore difficult, if not impossible, to integrate the two perspective in one definition. Juran (1998) showed that there has not been reached a consensus regarding the meaning of the concept of quality, as shown in Table 1.

Furthermore, on the background of controversial debates, practice shows that there can be identified a series of key-terms which manufacturers prefer for the definition of the concept of quality, as shown in Table 2.

Beside the lack of structure and many arisen controversies, the speciality literature synthesizes a series of perspectives with a wide comprehension of the field of quality.

Corresponding Author: Răzvan Giuşcă, 43 Dimitrie Mangeron Blvd., Iasi, 700050, Romania
Tel: 40-232-254638 Fax: 40-232-233368

Table 1: Major senses of quality and the description of the products in order to convince the user

Characteristics of products/services that satisfy the demands of consumers	Lack of deficiencies
A high level of quality enables:	A high level of quality allows firms:
To increase the level of satisfaction of consumers	To reduce the number of errors
To realise saleable products	To reduce the number of rejected products
To face the competition	To reduce the number of functioning errors and repairs under guarantee
To increase the market share	To reduce the level of dissatisfaction of consumers
To realise sales income	To reduce the number of inspections and testing activities
To practice competitive prices	To reduce the launching time of new products
	To improve the level of use of the production capacity

Table 2: Key-terms used for the definition of quality

Frequently used terms	Controversial terms	Less-frequently used terms
The quality of services:	Internal processes (such as recruitment)	Price
Characteristics	Duration of fabrication cycles	Costs (other than those resulted from deficiencies)
Performance	Promptitude	Absenteeism
Competitiveness	Lack of errors	Social responsibility for the employees, environment or public
Kromptitude	Competitiveness	
Kourtesy	Safety at the work place	
Kapability of processes		
Lack of errors		
Conformity to standards		
Conformity to procedures		
The quality of products:		
Characteristics		
Performance		
Competitiveness		
Friendly interface		
Safety functioning		
Lack of functioning errors		
Feasibility		

QUALITY PERSPECTIVES

Agreeing to other researchers Garvin (2000) defines five perspectives of quality.

The transcendental perspective: Although quality cannot be defined, one knows what it is (Pirsig, 1974). From this perspective, quality is synonym to excellence, both absolute and universally renowned, resistant to fashion and tastes. Sometimes, it is equivalent to craftsmanship, excluding the idea of mass production. Yet, most often, quality cannot be defined, being a simple feature we learn to recognise based on experience. Therefore, whatever quality may be, people will recognise it when they see it.

The product's perspective: The qualitative differences reported to quantitative differences of some desired components or attributes (Casson, 2003). Quality refers to the number of non-quantifiable attributes contained by any quantifiable attribute of a product.

From the product's point of view, quality is a concrete and measurable characteristic. In this case, the qualitative differences are given by the quantitative differences existing between the characteristics of a product. For example, a quality Persian carpet has a high number of knots per square centimetres. This perspective implies a hierarchical approach to quality where the products are classified depending on the number of the desired characteristics they possess. These are some of the implications of the product's perspective related to quality:

- Since, quality is given by the number of characteristics each product have and each characteristic implies specific costs, then high quality products are usually most expensive
- Quality is perceived as an inherent characteristic of products and not something that can be attributed to products; since quality reflects the presence or absence of some measurable characteristics of the products, it can therefore be measured objectively and it is based on elements that exceed individual subjectivism

The user's perspective: Quality consists of the capacity to fulfil demands. The quality of a product depends on the manner it satisfies the requests of the user. Quality represents the capacity of the product to be used (fitness for use) (Juran, 1998).

This perspective leads to the following approaches:

- Marketing-precise combinations of the characteristics of a product that provide the highest level of satisfaction for a determined consumer
- Economy-the qualitative level of a product is defined by the changes of the curve of demand

- Production management-the capacity of the product to be used (fitness for use)

The implications of the user's perspective on quality:

- The issue of aggregating different individual preferences so as to provide significant definitions of quality at the market level
- The problem of identifying quality with the clients' satisfaction-even if the two concepts are connected, they are not identical. For every individual quality may be equal to satisfying his or hers specific needs, therefore, from this point of view, quality may mean different things for different people. On the other hand, the preferences of consumers are also influenced by the tendencies of fashion and market, even though they don't objectively reflect the qualitative level of the product

The producer's perspective: Quality means conformity to requests (Markham, 2000). Quality represents the extent to which a certain product is conformant to a project or stipulation.

Therefore, all definitions within this perspective consider quality as being equal to conformity to certain demands. The level of quality is given by the deviations from stipulated specifications. In this sense, excellence is equivalent to getting things done right from the first time.

For example, the quality of a Rolls Royce well done is similar to the quality of a Daewoo well done. In this case, the accent falls on the internal aspects of the manufacturer, respectively on design and production control. In the design field, the focus is mainly on feasibility, while in the production field the accent is on the statistic control of quality, although the main purpose of both fields is to minimize deviations from stipulations and consequently, to reduce costs.

The value perspective: Quality represents the level of excellence at an affordable price, together with the control of variability at an affordable cost (Nersesian, 2000). Quality means the best depending on certain demands of the consumer: (a) effective utility and (b) sale cost of the product.

In this case, quality is defined mainly in terms of price and cost. A quality product is a product that provides performance or conformity at an affordable/acceptable price or cost. For example, a salami which costs one million dollars per kilogram, no matter how well done, tasty or good it may be, it is not considered to be of quality since it would have very few buyers. Although, it has a special importance, this perspective is rather difficult to be applied in practice since it implies a combination of two concepts bound between each other, yet very different: excellence and value. The result would be a subjective hybrid with quite diffused limits: Excellence that one can afford.

Table 3: A synthesis of quality definitions as related to costumer demands

Definitions of quality
The totality of elements and characteristics of a product/service that define its ability to satisfy explicit or implicit demands
In the eyes of the beholder
Right from the first time
Precise measurement
Conformity to demands
Fitness for use
Fitness for purpose
Fitness of purpose
The client's level of satisfaction
The capacity of a product/service to satisfy a specific need

Obviously, integrating all the above perspectives leads to satisfying the client's demands as being the unifying element, which is also the conclusion expressed in so many ways in the speciality literature (Table 3).

Evolution of the approach on quality: Although quality is a vague term, its roots are deeply set in history. In 2150 BC, the Hammurabi's Code prescribed regulations regarding the quality of residential constructions. If a constructor builds a house for another person and his work is not resistant and the building collapses and kills the owner, that constructor will be sentenced to death.

One of the oldest feed-back systems related to quality was found in the tomb of Rekh-Mi-Re of Thebes, Egypt (1450 BC). On the funerary star, it is represented the figure of an Egyptian who is measuring a stone block with a string. Archaeological discoveries offered many data on systems used to provide quality in daily activities in ancient Greece. Also, it is well known the fact that Phoenicians used to cut down the right hand of those who provided unsatisfactory products or services.

The systems used to provide and improve quality knew a rapid evolution during the last years. During the 20th century, the simple activities of inspection were replaced or completed with the use of statistics and quality control. The concept of ensuring quality became more refined and developed. Nowadays many companies wish to progress towards a management of total quality.

Within this process of development of the organisation, there can be identified four stages: Inspection (I), Quality Control (QC), Quality Assurance (QA) and Total Quality Management (TQM) as shown in Fig. 1. The first two stages imply detection of malfunctions, while the next two refer to preventing them.

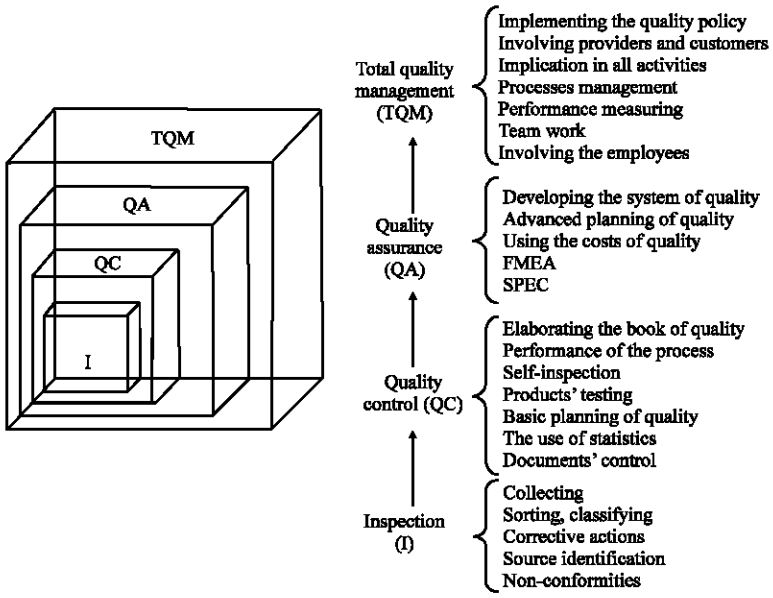

Fig. 1: Four stages in the evolution of quality management

Inspection (I): In the beginning, inspection was considered to be the only way to assure quality. Within a system based on inspection, one or more characteristics of a product, service or any other activity are analysed, measured, tested or evaluated and compared to specific requests in order to evaluate the level of conformity to a stipulation or standard of performance.

In a production unit and, most importantly in the construction field where the quality requests are extremely diverse, sometimes contradictory, the system is applied to raw materials, components and sub-assemblies fabricated at corresponding points in the process, as well as before the final products are introduced in the storehouse of finite products. In the field of public or commercial services, the system is also applied in some key-points of the production and delivery processes.

Inspection activities, which are going to be referred later on, can be conducted by specialized contracted personnel or by means of self-inspection. Raw materials, components and products that are not conformant to standards are considered rejected, remedied, modified, etc. In some cases, inspection is used to rank finite products from the quality point of view.

Inspection is a process of analysis-evaluation post-event, with no other warning elements except the identification of providers, operations or operators that produced goods/services which are not conformant to the provided stipulations.

Generally, the systems based exclusively on inspection do not directly involve in the activities the providers or clients.

Quality Control (QC): Form the point of view of methods, systems, instruments and techniques of the quality management, the quality control is a more sophisticated process than inspection is, having as result a reduced number of non-conformities related to the stipulations.

Within a system of quality control there are such elements as: documents and procedures control, testing raw materials and intermediary products, collecting data referring to performance, directed feed-back, etc.

The quality control does not improve quality, but it draws attention when the products/services are not conformant to the requests. Sometimes, such a procedure does not identify the cause of found non-conformities and using it in excess may lead to diminishing the number of responsibilities assumed by employees in their effort to improve processes they are involved in, since they will always expect their work to be controlled for conformity to pre-established standards.

Quality Assurance (QA): Detecting and solving the problems resulted from non-conformities is not an efficacious method to eliminate the cause of their occurrence.

Continuous improvement of long-term quality can be obtained only by directing the efforts of the company towards planning and preventing at source the occurrence of problems. This vision leads to assure quality, although in the field of constructions, no matter the type or destination, demands go a long way from the producers of raw materials, which are extremely diverse, to executioner and user.

There are some supplementary elements that develop in the process of passing from quality control to quality assurance:

- Using a formal system of quality management in order to increase uniformity and conformity
- Using the seven basic instruments of quality control (for example, bar graphs, control sheets, Pareto graphic, the cause-effect graphic, etc.)
- The statistic control of the processes (SPC)
- The analysis of methods of failure and their effects (FMEA-Failure Mode and Effects Analysis, in English literature and AMDEC-Analyse des Modes de Défaillance et de leur Criticité, in French literature)
- The use of quality costs

First of all, this approach marks out a reorientation from detection to prevention of non-conformities. The main accent is on the advanced planning of quality, the improvement of products, services and processes design and the improvement of control within the processes as well as the involvement and motivation of employees.

Total Quality Management (TQM): The term of total quality management was first introduced during recent years, some researchers suggesting that it was proposed by an expert in behavioural sciences from the United States Navy.

There are controversies about the term itself and its significance. Still, in 1991, the organism of standardization from Great Britain defined it as follows:

- TQM is a management approach aimed at all activities through which the needs and expectations of clients and community, as well as the organization's objectives are satisfied in the most efficient and economic manner by maximizing the potential of all employees with an on-going participation in improving activities
- This definition seems to correspond to the most comprehensive points of view related to quality management, according to which it becomes a synonym of good management, focused not only on specific quality activities, but mainly on all aspects concerning the management of the business itself

Dimensions of quality: Garvin (2000) proposes the following dimensions of the product's quality: performance, characteristics, feasibility, conformity, durability, serviceability, aesthetics and perceived quality.

Each of these dimensions is independent. A product that is considered to be of high quality from the point of view of one dimension could be of low quality when another dimension is considered.

Also, there are cases when a dramatic improvement of one dimension can be achieved only on the expense of another, as well as there are cases when two dimensions, for example feasibility and conformity, may have the same evolution.

Performance: This first dimension refers to the primary use characteristics of a product/service. For example, in the case of a TV set these characteristics refer to sound, clarity of image, colour, the ability to receive aerial signals, etc. In the public services field, performance is usually similar to prompt serving or the lack of long waiting times.

In the case of a construction, these characteristics are more ample: the quality of design and mainly of the strength structure, which has to be conformant to a multitude of factors that assure its stability and durability; the seismic risk of the place; the climatic environment (maximum and minimum temperatures, wind and snow action); environmental factors, the characteristics of the foundation ground, etc.

Furthermore, it must be considered the nature and quality of raw materials, the means of transportation, storage, preparation and working, as well as the building exploitation manner.

Therefore, performance in construction is due to a wide series of organizations that activates on the above mentioned route.

The performance of products/services combines the constitutive elements of two of the quality perspectives described above: the product's perspective and the user's perspective. It also implies the measurable characteristics of the considered product/service and it allows an objective hierarchy of marks from the point of view of at least one dimension of performance.

The hierarchy of marks based on the global performance of the product/service is more difficult to realize, especially when there are involved specific characteristics. In this case, these characteristics need to be examined in relation to the functions they have to perform.

For example, if the comparison is between two bulldozers, one of 100 $m^3 h^{-1}$ and the other 10 $m^3 h^{-1}$, then the hierarchy is rather obvious. The first bulldozer has a larger capacity and therefore provides superior performance.

Yet, let's presume that the two bulldozers have the same capacity 60 $m^3 h^{-1}$ but they realize this capacity in different ways: one bulldozer has a tank of 1 m^3 and

completes 60 cycles in 1 h, while the second bulldozer has a tank of 2 m^3 and completes 30 cycles in 1 h. The capacities of the two bulldozers are the same, while their capabilities are completely different. The bulldozer with the larger tank can manipulate larger volumes of ground, while the other one can execute tasks requiring accuracy. Which of the two bulldozers provides superior performance. Obviously, it depends on the task to be fulfilled.

The connection between performance and quality also depends on circumstances. The extent to which differences of performance are seen as qualitative differences depends on individual preferences. Usually, users have a wide range of interests and necessities and each of them consider quality in relation to his/hers own interests. The connection between performance and quality is also influenced by the expressing mode. The products' performance is frequently expressed using terms associated to quality as well as terms that do not make this association.

For example, a 100 Watt bulb produces more light than a 60 Watt one (performance); yet, only few users will consider this difference as a measure of quality, since they see the products as part of different classes of performance. On the other hand, the soundness of a car is typically considered a direct reflection of quality.

Therefore, soundness is a dimension of performance immediately translated in qualitative terms, while the bulb power of lightening is not. These differences seem to reflect in the same manner linguistic conventions and personal preferences of the users.

Secondary characteristics: Secondary characteristics are those elements that complete the basic functioning of the product, as for example the location of a building in a ward that is closer or farther away from the city centre, the possibility to connect to public utilities, access to railroads, etc. In the same category we can include the aesthetic and functional reasons: interior and exterior finishing, the performance of the running water plumbing, heating, air conditioning and other facilities offered by the current technology.

In many cases, it is rather difficult to separate the primary characteristics of the product (performance) from its secondary characteristics. The secondary characteristics, as well as the product's performance, consist of objective and measurable elements and their transposition into qualitative differences is largely influenced by individual preferences. Furthermore, categorizing one characteristic into a dimension or another is mainly a question of importance in the eyes of the user.

Feasibility: Feasibility reflects the probability of a product to go out of order within a specified time span. Some of the most used indicators of feasibility are:

- Mean time to first failure
- Mean time between failures
- Rate of failure on unit of time

Since, these indices require the use of a product for a large period of time, they are more relevant in the case of long-use goods than for products and services with immediate use.

Constructions are products with long or very long standard terms of exploitation; for this reason, it is decisively important to provide high quality for all products in order to have proper feasibility.

Usually, feasibility becomes more important for the consumers when the period of time allotted for repairs and maintenance is more expensive.

Conformity: Conformity represents the degree to which the design of a product and its operational characteristics are concordant with pre-established standards. The technical literature outlines two conceptions referring to conformity:

- Concordance with stipulations-American vision
- The function of losses

The first approach considers that all products or services require a series of specifications. In the design of new products/services it is necessary to impose (dimensional) standards for the simple components (for example, the admitted tolerances for a product's marks) and for the characteristics of raw materials and substances (for example, the composition of a certain type of concrete).

This vision of conformity is directly connected with the control of processes and sampling techniques. The limit-stipulations are determined according to the capabilities of the production process-the highest precision and the smallest variability in condition of controlled operation; the process is balanced so as to make sure that most of the products' marks are within the stipulated limits.

Considering this vision of conformity, quality means to respect certain tolerances, when the producers' interest for the central dimension is rather low and the dispersion within stipulated limits is most of the time ignored.

Despite all differences between the two approaches, they are both based on the same data of monitoring the production within different plants: measuring the

incidence of failures or the proportion of marks that are not within limit specifications and require supplementary repairs or interventions. If the traditional approach is used, a simple enumeration is enough.

In the construction field, the continuous attention for this dimension of quality is proved by the on-going improvement of calculus methods, the change of standards as new materials or investigation procedures appear, the treatment of new data related to the time behaviour of certain materials, the consequences of the ageing effect, etc.

In practice, the data on conformity are relatively difficult to obtain, so usually the solution is to refer to substitutes, such as the number of requests for service or the frequency of repairs within warranty. These indicators, although highly suggestive, neglect other deviations from standards that do not require service or repair, such as labelling or aesthetics.

In the public services field, conformity is mainly expressed by accuracy and punctuality and it includes the number of processing mistakes, unexpected delays and other errors with high frequency of occurrence.

Both feasibility and conformity are dramatically connected to production. The improvements carried out to the two dimensions are directly transposed in an improved quality, since failures or functioning errors are seen as virtually undesirable by all consumers. Consequently, failures or functioning errors constitute relatively objective indicators of quality and are less exposed to individual preferences than the hierarchies based on performance or characteristics.

Durability: Durability, as an indicator of time length of a product, has both technical and economical implications. From a technical point of view, durability can be defined as: the functioning time of a product before its physical deterioration (Garvin, 2000).

It is quite easy to interpret durability when the product's repair is impossible (for example, a bulb that went used and needs replacement). When the product can be replaced, the interpretation of durability becomes more complicated. New elements will be added, since the life expectancy of the product varies depending on the fluctuation of consumers' preferences (fashion, etc.) and economic environment.

In the construction field the repairs are rather difficult because the replacement of a structural element or its strengthening require considerable efforts, such as the ingenuity of the action, the technological difficulties and high costs. Works of consolidation are extremely meticulous and they require well-established technology and most of the times certain areas of the construction would not be used during repairs.

Durability in construction mainly refers to providing chemical stability of the materials, which cannot be affected by the multitude of aggressive environmental agents, as well as to assure structural stability for the elements that can be affected by repeated cycles of freezing-thaw, the action of wind, rains and even direct sunlight.

Therefore, durability becomes: the time of use of a product before any failure and when its replacement is preferred to repair (Garvin, 2000).

In this case, consumers have a series of alternatives. For every malfunctioning of the product, they have to consider the cost of future repairs, both as money and as personal inconveniences, compared to the necessary investment to buy a new similar and more feasible product. In this case, the life expectancy of a product is determined by a combination between the costs for repairs and the personal evaluation of lost time and other inconveniences, changes of fashion, losses resulted from delays and the relative costs due to the quality of components and the materials used to manufacture the respective product.

This approach of durability has two major implications:

- Durability and feasibility are interdependent. A product that frequently suffers failures is taken out of use sooner than one with higher feasibility, since the costs for repairs are higher and the alternative to buy a similar competitor product is more and more desirable; this consideration had as result the policy of life-time warranty for products and it is practiced by ever more manufacturers in the world
- Data regarding durability need to be cautiously interpreted. Increasing life expectancy of a product may not be the result of improved technical characteristics or the use of more resistant materials, but only the result of current environmental conditions

Even in comparable conditions of maintenance, durability varies significantly between different marks of the same product, suggesting that durability is a fertile field for qualitative differences (Garvin, 2000).

Service ability: The ability to provide service is defined as the speed, courtesy, competence and easiness to conduct repairs.

Clients are not concerned with failure only, but also the time needed for repairs, the punctuality and courtesy of the service staff and the frequency of unsuccessful tries to restore the product. The procedures regarding the

clients' complaints about the service activities also affect the evaluation of the quality of products or provided services.

CONCLUSION

As a conclusion, the quality of a product, as well its aesthetics, is a subjective dimension depending on the user's perspective. Since, consumers do not have complete information about the characteristics of a product/service, they usually use indirect criteria to compare different marks. For example, durability cannot be directly observed, but it needs to be deduced with the help of multiple tangible and intangible characteristics of the product. In this case, images, publicity and the brand's name, that is the perception of reality rather than reality, are most likely to weigh in the client's choice of a product. For example, many clients consider that the country of provenience is an indicator of a product's quality. Reputation is one of the main ingredients of perceived quality. Its power comes from the following analogy implied by the clients. The quality of present products is similar to the quality of products provided by a company in the past or the quality of new products is similar to the quality of traditional products of a specific brand. Although, being subjective, this reasoning is a highly and successfully used element in marketing campaigns.

REFERENCES

Casson, M., 2003. The Entrepreneur: An Economic Theory. 2nd Edn., Edward Elgar Publishing Ltd., Columbia, ISBN-10: 1858989108.

Garvin, D.A., 2000. Learning in Action: A Guide to Putting the Learning Organization to Work. Harvard Business Press, USA., ISBN: 1578512514.

Juran, J.M., 1998. Juran's Quality Handbook. 5th Edn., McGraw Hill, New York, ISBN: 007034003X.

Markham, C., 2000. How to be Your Own Management Consultant: Consultancy Tools and Techniques to Improve Your Business. Kogan Page, Kogan.

Nersesian, R.L., 2000. Trends and Tools for Operations Management: An Updated Guide for Executives and Managers. Greenwood Publishing Group, USA., ISBN-10: 156720225X.

Pirsig, R.M., 1974. Zen and the Art of Motorcycle Maintenance. Bantam Books, Boston, ISBN: 0553103105, pp: 185-213.