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1.2 Systemic Treatment of quality management (Quality Management System)

Total Quality Management (TQM): TQM is a set of management practices throughout the organization, geared to ensure the organization consistently meets or exceeds customer requirements. TQM places strong focus on process measurement and controls as means of continuous improvement.

Before reading more about TQM, it might be helpful to quickly review the major forms of quality management in an organization. These are briefly described at the top of the Quality Management topic.

Statistical Tools: Quality management must be based on facts. If we strive to improve and solve quality problems, we must rely on information and analyze it using reliable statistical tools.

Statistical tools that we can use are varied, and statistical analysis can be performed in several forms simultaneously. The process and the various factors in the process should be described in the form of a quality chain of customers and suppliers, to define the input and output of each factor and set the parameters we want to measure. You can test the endurance of the chosen parameters and test, for example, whether the different suppliers meet them. Such analysis will give a measure of the level of quality, and directions for examination for improvement. Other statistical analysis can be done by a histogram showing the distribution of the factors or distribution of defects. Using a detailed analysis, one can identify the most significant factors or deficiencies and treat them as part of quality circles or by any other corrective action. Another statistical analysis is examining the correlation between two data. Using scatter diagram, showing the dependence between a certain statistic data and another, it can be known whether there is a correlation between the data. If one of the data is an input of some other date, and there is a high correlation between them, one can strongly control the output data by the input data. If the two data are outputs of various factors then it is necessary to check the

common factor influencing them so strongly and resulting in a high correlation between them.

Another method for statistical analysis, which is rather complex and not suitable, for many reasons, for the field of construction, is the Taguchi method.

7 Important Principles of Total Quality Management: Total Quality Management (TQM) is an approach that organizations use to improve their internal processes and increase customer satisfaction. When it is properly implemented, this style of management can lead to decreased costs related to corrective or preventative maintenance, better overall performance, and an increased number of happy and loyal customers.

However, TQM is not something that happens overnight. While there are a number of software solutions that will help organizations quickly start to implement a quality management system, there are some underlying philosophies that the company must integrate throughout every department of the company and at every level of management. Whatever other resources you use, you should adopt these seven important principles of Total Quality Management as a foundation for all your activities.

The 7 Qualities Of Brilliant Executive Coaching [3. p. 24]

1. Quality can and must be managed: Many companies have wallowed in a repetitive cycle of chaos and customer complaints. They believe that their operations are simply too large to effectively manage the level of quality. The first step in the TQM process, then, is to realize there is a problem and that it can be controlled.

2. Processes, not people, are the problem: If your process is causing problems, it won't matter how many times you hire new employees or how many training sessions you put them through. Correct the process and then train your people on these new procedures.

3. Don't treat symptoms, look for the cure: If you just patch over the underlying problems in the process, you will never be able to fully reach your potential. If, for example, your shipping department is falling behind, you may find that it is because of holdups in manufacturing. Go for the source to correct the problem.

4. Every employee is responsible for quality: Everyone in the company, from the workers on the line to the upper management, must realize that they have an important part to play in ensuring high levels of quality in their products and services. Everyone has a customer to delight, and they must all step up and take responsibility for them.

5. Quality must be measurable: A quality management system is only effective when you can quantify the results. You need to see how the process is implemented and if it is having the desired effect. This will help you set your goals for the future and ensure that every department is working toward the same result.

6. Quality improvements must be continuous: Total Quality Management is not something that can be done once and then forgotten. It's not a management "phase" that will end after a problem has been corrected. Real improvements must occur frequently and continually in order to increase customer satisfaction and loyalty.

7. Quality is a long-term investment: Quality management is not a quick fix. You can purchase QMS software that will help you get things started, but you should understand that real results won't occur immediately. TQM is a long-term investment, and it is designed to help you find long-term success.

In Table 1, there is a description of the different roles of each factor, and its commitments to achieving continuous improvement of the process, as described by Juran [36, p. 163].

Table 1 - Continuous Improvement Practices [2, p. 16]

Responsibility for Quality		
As a Customer	**As Process Executive**	**As Supplier**
Define my requirements from the supplier clearly and in a documented manner	Measure the means of quality and measure others	Understand the customer's requirements, document and track the products I provide
Return defective products	Constantly improve my processes, reduce defects and work duration	Reduce defects and variance in my products
Provide feedback for the supplier on the quality of his products	Document and present my method of work, the defects and my plans to improve quality	Measure the quality of the products from the point of view of the customer

Deming describes the process of continuous improvement through a cycle called the "Deming Cycle" [46, p. 88] in which four recurring tasks are described which are required for continuous improvement. Figure 6.

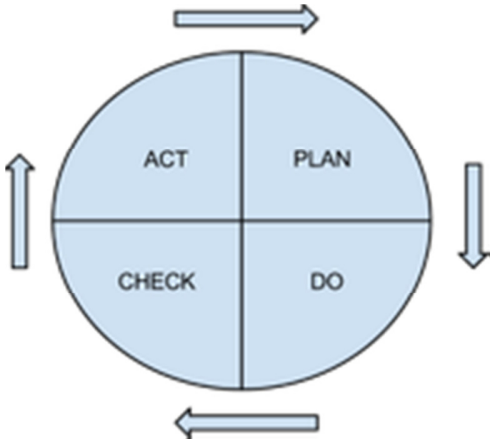

Fig 6 - Deming's Continuous Improvement Cycle [2, p. 16]

The Model of the TQM Method: TQM method is described in different ways. One possible model of the theory is the model of Kanji & Asher, 1993. They argue that there are four guiding principles, and 8 core concepts which describe total quality management. The guiding principles and core concepts are described in Table 2. The model is depicted in Figure 7.

Table 2- Principles and Core Concepts of TQM [2, p. 17]

Principles	Core Concepts
Please the Customer	Customer satisfaction Internal Customers are Real
Management Through Facts	Every Job is a Process Measurement
Management Based on People	Teamwork People Make Quality
Continuous Improvement	Continuous Cycle Prevention

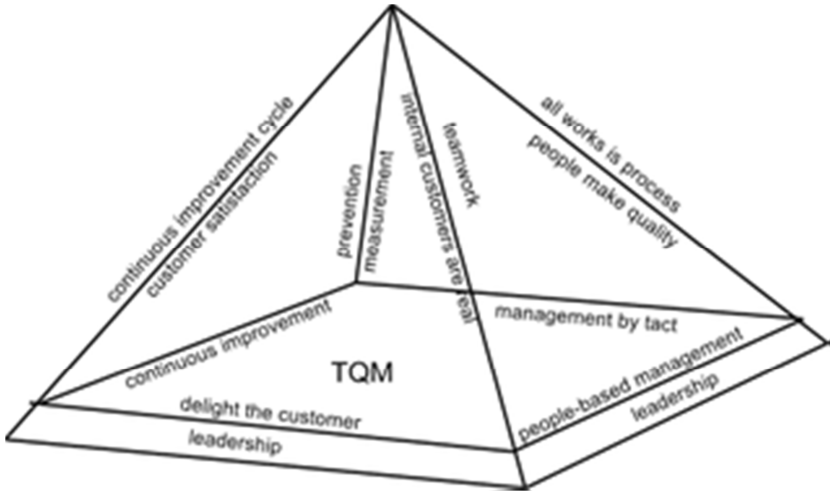

Fig 7 - Pyramid Model of TQM [2, p. 17]

Tools for Implementing Total Quality Management: The means for establishing the method can be described using the model in Figure 8 [39, p. 454].

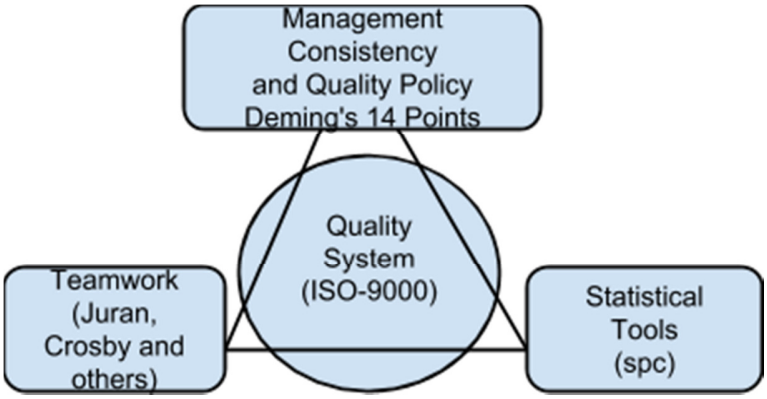

Fig 8 - The Implementation TQM Model [39, p. 454]

Management Constancy and Quality Policy: Management constancy and the quality policy of an organization can be defined in many forms. Guidelines can be found in

different places. The most common source is Edward Deming. Here are the 14 points of Deming [46, p. 23]:

1) Create constancy for continuous improvement of product and service, in order to create a competitive advantage.

2) Adopt the new philosophy. We cannot continue to live with acceptable levels of delays, mistakes and defective manner of execution.

3) Cease dependence on mass inspection. Institute statistical tools, instead, that would prove that quality is structured.

4) End the practice of working with suppliers on price tag alone.

5) Constantly and forever improve the system of production and service. That will increase the quality and productivity, as well as reduce costs.

6) Institute modern methods of training on the job.

7) Shape a leadership that aims to help people perform their work better. The responsibility of managers and supervisors must change from numbers and quotas to quality.[4. p. 32]

8) Drive fear out of the organization. Allow everyone to work efficiently for the organization.

9) Break down barriers between departments and areas. Employees of various departments must work together to solve problems and improve quality.

10) Eliminate slogans and exhortations. Eliminate demand for "zero defects" and for a higher level of efficiency without giving means and methods to do so. Quality problems are anchored in the method, not in the employee.

11) Eliminate goals and numerical quotas, including management by objectives**.**

12) Remove barriers robbing workers of their right to pride in their work. The intention is to eliminate the rating system of workers according to their performance and to cancel management by objectives.

13) Institute a vigorous program of education and training and encourage everyone to improve.

14) Make sure that all people in the workplace work to realize the change.

1.3 Models of Quality Management System: Content and scope

Introduction: Parallel to the development of quality control, quality assurance and total quality management, different methods were developed to prevent the wastage of the majority of the benefit from the production process. These methods are: JIT, Value Engineering and Constructability. Some were even developed in the same places and at the same time as the sophisticated approaches to quality management. JIT, for example, was developed in Japan during the same years and in the same factories in which quality circles and the TQM method were developed.

Described below are methods developed over the years:

JIT – Just In Time: JIT is a collection of management philosophies developed in Japan. The approach defines the term "waste" as everything from the absolute minimum amount of resources needed to produce goods and services. The approach focuses on immediate improvement in productivity by reducing costs associated with inventory and include direct costs of purchasing, financing, storage, insurance, security, inventory obsolescence and more.

JIT is, without doubt, a far better quality management method, in addition to it being a technique for improving productivity that can generate short-term benefit as well. JIT objective is maximizing the timing of delivery or receiving of inventory of accurate quantities. According to JIT approach, the required inventory is pulled into the work process on a basis of small portions. Materials or labor or inventory in the process are provided only when they are needed by the subsequent workstation. The movement of inventory or labor is done from the supplier to the workstation directly.

The supplier and subcontractor must also be part of the process and act according to the method of JIT themselves. Otherwise, waste costs resulting from excess inventory at the supplier will roll to the prime contractor and then to the customer. To have suppliers and

subcontractors participate in a "new game", one must establish a relationship of long term cooperation with them. One should avoid common approaches of attachment with suppliers and subcontractors which essence is multiple suppliers per product and attachments on the basis of price tag alone.

The manner of the new attachment should be based on economic interests, as in any business attachment, but on trust and partnership. Each product should have a minimum of number of suppliers and the attachment with them should be based on quality and price together. The need for a new type of attachment led to a new concept in the business world which is "Partnering".

Partnering: "Partnering" is a concept developed in recent decades and it means: a (usually) long-term business attachment between parties, with a joint effort based on open communication, mutual trust and cooperation, in order to achieve the objectives of all parties involved. Partnering is supposed to improve efficiency and yield, to encourage innovation and continuous improvement of product and service quality [12, p. 27].

Partnering is basically breaking conventions of accepted modes of attachment between organizations. The new concept is a unified culture and breaking boundaries and barriers between attaching organizations. The goal is to make the most of every participant in the process by removing obstacles of lack-of-trust, fear and lack of cooperation.

The connection between quality management and partnering is almost obvious. It can be said, in a simplistic manner, that partnering is implementing Deming's 14 points, not only within the organization, namely: for the contractor or developer and so on, but referring to the project and to all the parties in the project as one organization implementing Deming's 14 points.

Quality assurance (QA): Quality assurance (QA) refers to the systematic activities implemented in a quality system so that quality requirements for a product or service will be fulfilled. It is the systematic measurement, comparison with a standard, monitoring of processes and an associated feedback loop that confers error prevention. This can be

contrasted with quality control, which is focused on process outputs.

Two principles included in QA are: "Fit for purpose", the product should be suitable for the intended purpose; and "Right first time", mistakes should be eliminated. QA includes management of the quality of raw materials, assemblies, products and components, services related to production, and management, production and inspection processes.

Suitable quality is determined by product users, clients or customers, not by society in general. It is not related to cost and adjectives or descriptors such "high" and "poor" are not applicable. For example, a low priced product may be viewed as having high quality because it is disposable where another may be viewed as having poor quality because it is not disposable.

Quality control (QC): Quality control (QC) is a procedure or set of procedures intended to ensure that a manufactured product or performed service adheres to a defined set of quality criteria or meets the requirements of the client or customer. QC is similar to, but not identical with, quality assurance (QA). QA is defined as a procedure or set of procedures intended to ensure that a product or service under development (before work is complete, as opposed to afterwards) meets specified requirements. QA is sometimes expressed together with QC as a single expression, quality assurance and control (QA/QC). [3. p. 46]

In order to implement an effective QC program, an enterprise must first decide which specific standards the product or service must meet. Then the extent of QC actions must be determined (for example, the percentage of units to be tested from each lot). Next, real-world data must be collected (for example, the percentage of units that fail) and the results reported to management personnel. After this, corrective action must be decided upon and taken (for example, defective units must be repaired or rejected and poor service repeated at no charge until the customer is satisfied). If too many unit failures or instances of poor service occur, a plan must be devised to improve the production or service process and then that plan must be put into action. Finally, the QC process must

be ongoing to ensure that remedial efforts, if required, have produced satisfactory results and to immediately detect recurrences or new instances of trouble. [10. p.93]

VE – Value Engineering: Value engineering is an organized approach for identifying and eliminating unnecessary costs. The purpose of value engineering is to provide the necessary functions required from a product at the lowest price. Value engineering started out in American industry in the 40s. Following the shortage of raw materials, an exploration of options began in order to provide alternative existing components. The development of this way of thinking resulted in that many replacements provided equal or better performance at low costs. On the basis of the results obtained, value engineering was based.

In the analysis of unnecessary costs, the following points should be examined:

- Functions: functions that do not match the product designation are not necessary.
- Lifespan: the lifespan of each component in the product should be balanced with the life of the product.
- Quality: cost reduction does not come at the expense of quality.
- Appearance: the appearance of the product is, at times, one of the most important components to the customer, and therefore must be considered at the time of cost reduction.

Value engineering is performed by a multidisciplinary staff which includes customer representatives, designer, executive, purchasing and marketing people and more. Value engineering is performed in a number of steps:

- Orientation: analyzing the product and its comprising components, and defining the functional needs for each component from the perspective of the customer.
- Info: coming up with reliable information about costs, quantities, sketches, specifications and methods of execution. The quality of decisions depends largely on the quality of the information.
- Creativity: raising ideas and solutions to problems using the technique of "brainstorming" and then examination them.

- Analysis and Evaluation: Assessing the monetary value of the ideas and ranking them by the profit inherent in them.
- Planning: Preparing an execution plan for the various participants in the process: the designer, the executives, purchasing and more.
- Performing a "Pilot": presenting the execution plans for the various participants in the process, performing a "pilot" and further examination.
- Summary and Conclusions: summary of results and start of execution.

Constructability: Constructability, the ability to construct, is defined as "the optimal way for use of knowledge of construction, planning, purchasing and executive experience, to achieve the project goals". The way in which constructability is performed is by teamwork and improving attachment between the parties involved in the project - developer, architect, designer, various consultants and the executive body. [7, p. 45]
Constructability is designed to prevent high costs, which are costs of non-quality, resulting from the detachment between design and execution through the integration between the two as done previously by "Master Builder." The Master Builder was responsible for all project operations - preliminary design, detailed planning, purchasing and organization of execution. During the planning, the Master Builder focused on all aspects of the project and took into account the effect of early decisions on the execution of the construction process.[10. p. 12]

Quantitative benefits of application by analysis are:[7. p. 10]

- Reduction of engineering costs resulting from the use of standard components and planned details.
- Reducing construction costs resulting from the effective use of labor force by early producing, early assembly and modular methods.
- Efficient use of building materials, mechanical equipment and manual tools.
- Shortening the duration of the project

Quality Procedure System: The heart of this method is the Quality Procedure System, which contain, within itself, procedures, definitions and documentation of the quality

subject in a company, and can be used as the major anchor for total quality management of a company. Today the most common model of such a management system is the international standard ISO-9000 or, in its local version, Israeli Standard 9000.

Teamwork- Establishing Teamwork: To develop teamwork, one has to go through the steps described in Figure 9 [39, p. 36].

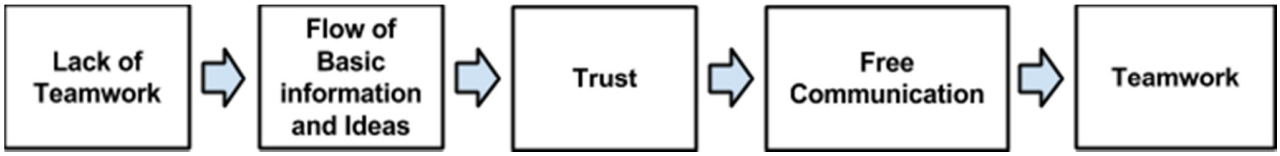

Fig 9 - The Transaction into Teamwork [2, p. 19]

While establishing teamwork, one has to care for the flow of information and ideas in the organization. Everyone at all levels needs to understand what is happening in the company or organization. Flow of information gives a sense of partnership and a sense of importance to every employee.

Establishing trust is the next step. The worker is not lazy person who aims to earn maximum salary with minimal effort, but a person proud of his work. If an employee makes a mistake, it could be a number of reasons, but it is not because he meant it. Establishing trust in the worker enables him to discover the deficiencies in processes and ways of working. Taking a problem-solving approach rather than blaming the person who discovers the problem will lead to teamwork and improvement.

Free communication in the organization allows employees to reveal the problems without fear of punishment. In a workplace where employees express themselves freely and without fear can establish teamwork. The change needed is in the atmosphere and the attitude, and must be transported from senior management down to all levels. If senior management encourages, consciously, an atmosphere of openness and trust, teamwork

and organization will be allowed. To enable teamwork and to maximize it, it is recommended to establish Quality Circles which have been proven to be most beneficial and effective in construction sites [2. p. 28].

Empowerment: An additional and much broader way, which requires a change in the structure of the organization, is employee empowerment and a transition to self-management teams. In many organizations, TQM implementation process is accompanied by the transition to management by self-managing teams and employee empowerment. TQM is often associated with this process of "empowerment" more than with any other concept. There is no known attempt in the construction industry for empowerment and a self-management team, and it is possible that these methods are not so suitable for the construction industry, but understanding them can contribute to the understanding of what teamwork in its purest way possible.

Quality Circles: Quality circles are some of the ways to create a team in an organization. Deming and Juran Deming are considered the fathers of Quality Circles. Juran defines them as follows: "a quality circle is a group of employees from the same department, who volunteered to devote time, beyond their normal working hours, to solve problems of their own department" [36, p. 18-19].

Quality Circles began as circles of quality control. Following much success in solving quality problems, they began to naturally deal with other problems related to their work. Techniques developed for tracking and analyzing quality problems were found suitable for other issues as well, and within a few years, the framework of goals for these circles expanded also to production problems, productivity, cost savings, wastage prevention, safety, environmental conditions, and so on [2. p. 90].

The typical work process in quality circles is depicted schematically in Figure 10, [2. p. 20].

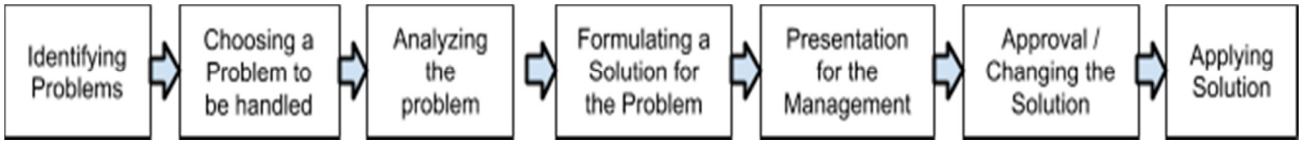

Fig 10 - The Typical Operation Process of a Quality Circle [2. p. 20]

The basic techniques used by the circle mainly include:

A	Brainstorming
B	Data Collect Processing
C	Pareto Analysis
D	Cause & Effect Diagrams
E	Management Presentations

Drawing on the employees themselves for tracking and solving the problems stems from the assumption that people engaged daily in their work know its weak points and problems in particular, and are able to offer practical ways to solve them.

International Standard ISO-9000: [4. p. 19] International Standard ISO-9000 largely answers these questions in that it lists the minimum requirements necessary to establish a quality system in any organization. This, perhaps, is one reason why the standard ISO-9000 became the new object of companies and organizations in the Israeli domain of construction interested in improving quality.

But this is a mixed blessing. In defining the requirements of a quality system in the form of a standard, there are also dangers. The standard defines minimum requirements for implementing a quality system, and thus may limit the motivation to develop the subject of quality in a company or organization to higher levels. In addition, the fact that there is a qualification and certification for the quality system may create the illusion that after receiving the stamp of approval, the quality system works properly, and seemingly the job is finished. Finally, the stamp of approval becomes a long-awaited character of its own and may cause companies to want to boast about it more than to improve quality.

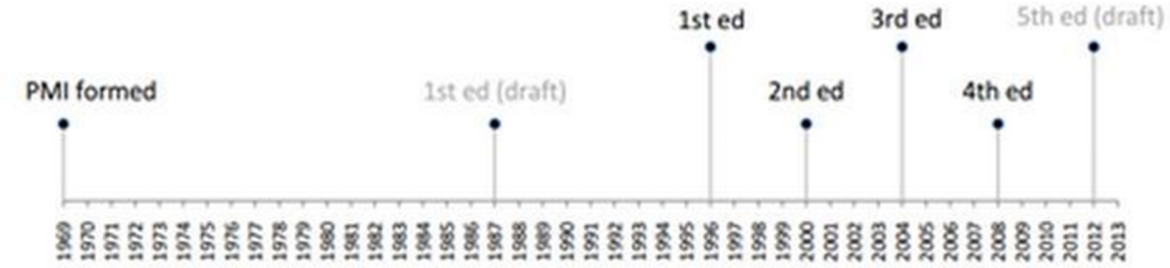

Fig 11. timeline of the PMBOK Guide editions [7. p. 9]

ISO-9000 is the model on duty for implementation of a quality system in various industries around the world, but for the Israeli construction branch (in generalization) its implementation is an initial experience in managing quality in a large-scale.

Implementation of ISO-9000 in a construction company or public body is, if so, a very contemporary subject, but it is also a meeting of ways between two developed research areas, with a long history, and they are: function in the branch of construction on the one hand, and quality management, on the other. In the survey of literature, an effort is made to explain this meeting in detail and depth, while emphasizing the development of the area of quality management in general, and the implementations of quality management in the construction branch in particular.[4. p. 19]

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