

ROAD QUALITY MANAGEMENT

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Abstract. *Traffic roads building is one of the most complex production processes in civil engineering. It is the most extensive one concerning the quantity of works executed and the most significant one concerning the scope of financial resources expended. The building of such and object inevitably requires the management of quality. The paper points out the significance, specific quality and application of the management of quality in the processes of traffic road building. Considerable outlays for the repairing of a low-quality traffic road represents a further motive for introducing the management of quality into the processes of traffic roads building. Beside these direct outlays, there are also indirect outlays caused by the delay of the traffic road building. As the outlays for the repairing of a low-quality traffic road noticeably exceed the outlays for the introduction of the management of quality systems, their introducing into the processes of traffic roads building becomes a necessity for planners, designers, subcontractors and contractors.*

Key words: *Traffic ways, management, quality.*

1. INTRODUCTION

Since the earliest days, in order to withstand the struggle with the nature, even when the simplest tasks were performed, there appeared a need for planning, organising, managing and the quality of products and services. In the beginning, man did it intuitively, later due to his experience and lately it is completely scientifically based. In the pre-historical period man founded the quality control, which was based on experience but was later to achieve the level of a scientific discipline in the course of development, the one the human society cannot efficaciously develop without. The Total Quality Management is a contemporary approach to the improvement of quality, and represents the additional efforts of an enterprise to satisfy the increased demand of the customers. It is a new business philosophy which is at the same time both a science and a skill, and it is connected to the mankind's endeavor to survive in the constant struggle called life.

With the appearance of the machine labour in production there is an accelerated development of the management (19th century) which was characterised by the separation of the capital ownership and its function. It resulted in the owners becoming the renters and the capital being managed by the expert managing teams – the managers. They were entrusted the business of management because they do it better and more successfully than the owners. The managers have the absolute right of managing the means, processes and the people participating in those processes. During the last decades of the last millennium, especially during the recent years, the managers have paid special attention to the quality management. The world is obsessed by the improvement of quality, and scientific and expert meetings at various levels, dealing with the question of quality are held on a daily basis.

In our country, as well as in many other countries facing the enlivenment of the market business, the improvement of quality began to be massively treated by various economic and non-economic enterprises. That could be expected, because the trade business is inseparable from the quality management, as it is inseparable from the management. It may be said that an efficacious market business cannot exist without the contemporary methods of quality management. In the civil engineering practice, the quality management found the great and significant application since the early days of its existence, which could be expected if the immense finances this branch of economy engages for the realisation of the investment projects are taken into account. It can be said that the quality management is an indispensable and universal tool of the contemporary civil engineering.

The efficacious quality management is necessary for the normal functioning of each system in an enterprise, but also for the enterprise in its entirety. Along with the progressive specialisation of the executives of certain production processes in the civil engineering, the more complex activities assigned to the executives, wider range of activities and increased number of the individuals in the enterprises which are engaged in the preparation and execution of a job, the quality management becomes more and more significant. The quality management, or better said total quality management is an unavoidable scientific discipline and the skill in many economic and non-economic branches.

2. TOTAL QUALITY MANAGEMENT IN CIVIL ENGINEERING

The successful management in the civil engineering is nowadays inconceivable without the Total Quality Management - TQM. The TQM comprises three spheres of changes in the enterprises: the employees, the technology and structure. And when we speak about the quality at the end of this millenium, its characteristics should not be lost from sight:

- The improvement of the quality as of a global concept of the enterprise;
- The high quality of products and services is an aim of all the employees in the enterprise;
- The only measure of the quality is a satisfied customer;
- The most efficient marketing message is the high quality of a product or service.

The TQM is defined in many ways, but it is certain that it represents the bigger orientation of the enterprise towards: the consumers – customers, higher quality of products or services and the change of the culture of work and life.

Out of the multitude of definitions of the TQM, we should point out the ISO 8402 definition: The TQM is the approach in an enterprise management, concentrated on the quality of the products or services and based on the participation of all their members, directed to the long term success by the satisfying the customers and for the benefit of all the people in the enterprise and the entire society.

The basic and the key elements of the TQM are:

- team work at all levels,
- complete and unreserved support for the TQM by the managers at all levels
- permanent improvement of the production system
- measuring and evaluation of the achieved results,
- permanent training of the employees at all levels, and
- satisfying the customers demands, as an ultimate and infallible quality arbiter

The TQM is a revolution in thinking and an evolution in the system of work and business. It may be considered a managing philosophy beginning with a customer, and by no means with the production lines, profit, loss etc.

3. SPECIFICS OF THE EARTH WORKS QUALITY MANAGEMENT

Construction works in road building are specific primarily because of the incoherent materials built in these objects, then because of the great transport distances, extensive production and large financial investments in building up of those objects. To this, we should add the unreliable geo-technical bases and the influence of the atmospheric conditions to the road building. Thus every project of the earth works represents a unique challenge. Such projects are incomparable with the industrial production. Different phases of the earth works are realised with the mutual cooperation of the investor, project maker, caterers of different materials, organisations for testing and control of quality. All the participants in the completion of different phases of the object are responsible for the quality of the earth works.

The quality of the earth works is expressed by the bearing capacity and the settlement of the foundation and the stability of the of the cutting and embankment sides. The examinations carried out during and after the building do not guarantee the quality of the executed works in the long term period, as they should when such objects are in question.

The principles of the quality management by the ISO 9000 and EN 29000 are basically much more difficult to apply in the earth works field than with the other civil engineering objects, and incomparably more so than for the industrial products, for which the mentioned quality management principles are designed for. This becomes clearer when we bear in mind that:

- The earth works are not designed and executed on the basis of the universal procedures recognised in all countries. On the contrary, there are the different procedures in different countries, which is understandable if the following is taken into account: different climate-meteorological conditions, geo-technical, cadre, economical specifics of the individual construction sites;
- As the designing and executive procedures of the earth works are different, it is not always possible to realise the required quality of the investors;

- At the earth works, it is a common case that an object was built according to the pre-arranged obligations, but that it has not the quality expected by the investor. Sometimes the pre-arranged requirement of the investor cannot be checked and proved, because there are no prescribed operational procedures which would enable such control and proof; and
- At the earth objects on the roads, the foibles and damage appear most frequently after a long period of time, which is not the case with the industrial products. That compels the investor and the executive to estimate the period after which the foibles and damage will appear, which is contrary to the generally accepted concept of the quality management.

If all said about the specific of the quality management of the earth works in road building is bore in mind, then the problems faced by the engineers striving to apply the concepts and plan the quality management in the earth works, can be understood.

4. THE APPLICATION OF THE QUALITY MANAGEMENT SYSTEM OF THE EARHT WORKS

The procedure of ensuring the quality described by the ISO 9000 standards can be applied to the earth works to some extent. It is because the required quality of the investor (the level of usability, period of construction, price...) cannot be expressed exactly and bound by the dead-lines and indications, because in most cases, when the earth works are in question, those are the stochastic processes. An example: the adequate quality cannot be expected, if there are no reliable methods for the objective defining of the quality.

In the objective determination of the earth works quality, there are greater difficulties partially due to the lack of the precise methodology and the rules of design and construction of the earth objects. In great part, this is the consequence of the constant change of work conditions, because of the significant influence of the changeable meteorological and geological conditions. Very seldom, the built objects entirely match the designed objects, and very often the already designed objects, after the beginning of their construction and the establishing the real condition, are re-designed and changed in the course of construction.

The application of the quality system in the field of the earth works has not improved significantly, at least not as was expected, and surely not as it was the case with the industrial way of production. It is the consequence of:

- The inertia and avoiding of the risks which would appear upon the introduction of the new methods of control. Such attitude of the investors is unfounded, because the quality control introduction would effect the significant improvement, and the probability to attain an earth object according to the required quality of the investor would increase.
- The engineers' fears of the reduction of their engagement and influence in the consulting and control works. Such fear is unfounded, because, the engineers would only have the more efficient way of control in the conditions of the earth works execution according to the control plans via the introduction of the quality control according to the ISO 9000 standards.

- The insufficient trust in the executive that it will correct its own mistakes if the responsibility for the control of quality were transferred to it. In fact, the profit of an executive would be in the higher preciseness of the contract (in respect to the quality) and smaller probability of the onset of the works which ought to redone.

5. CONTROL OF THE ROAD-WAY CONSTRUCTION

The material for the road construction and its road-way construction is controlled before the standards of the ISO 9000 series appeared. The material quality control is executed in different periods of the road-way construction building in different time periods of construction. These material control have their place in the quality procurement system. It has been regulated by the ISO 9001, 9002, and 9003 standards which are dedicated to the previous acceptance of the materials, coordination of the procedures, acceptance examinations and testing equipment.

The control programs should be introduced in the operational procedures or in the project quality plans. The material can be used only after the positive outcome of the executed control before the installment into the construction. In the course of construction, the supervision and the control of the prescribed building procedures is performed, which checks the matching with the standardised requirements. At the end, the control is done in respect to ascertaining if all the prescribed tests for the material testing and control in the course of road-way construction have been executed.

The plans for control of the road-way structure should contain:

- Control and testing of the dispatched materials immediately before the building in (material certificate, control at the place of production or better at the very construction site);
 - Control and testing of certain parts of the object in different phases of construction;
 - Final testing at the final takeover of the object.
- Those controls and testing are executed in three separate levels:
- The first level of control is done by the manufacturer, and that is the internal or self-control. In the quality system domain, the largest part of quality verification is transferred to the executive. The executive is obliged to prove, in the course of construction and after it, that the works have agreed with all the requirements from the contract. The results of the self-control of the executive represent the input data for the quality check;
 - The second level of control is executed by the investor, represented by the supervising organ. The supervising organ executes controls and testing in the course of construction, and pays special attention to the "vulnerable" spots. The vulnerable spots have to be precisely defined by the contract and the plans of control. After obtaining the positive results of the control and testing of the vulnerable spots, the supervising organ approves the continuation of the following activities with its signature. In case of the negative results, it is necessary to amend the defects, and after acquiring the positive results of control continue the activities on the object; and
 - The third level of control is the so-called external control, done through the independent laboratories. They have to be authorised by the state institutions for that activity.

For each testing it is necessary to define:

- the performances that should be provided,
- permissible tolerance,
- admission criteria,
- methods of testing and measuring,
- necessary equipment, and
- requirements in respect to measurement precision.

The methods of measurement may be issued by the different organisations: International Standard method; national method; responsible road managing methods; and the methods commonly approved by the road management, designing bureaus, material manufacturers, construction executives and researchers. It should be pointed out that in the road building in the recent years a new technique and technology for checking and establishing the construction quality, control and testing in the fields of road building (automatisation, robotics, teledetection...) is developing.

When it comes to measuring, control and equipment for the testing, the provider of the equipment ought to check, standardise and maintain his equipment operational. In that manner the precise measurement is enabled, else it would be unreliable. This is possible only when a unified national institution for measurements and standardisation, which would authorise the laboratories for issuing the standardisation certificate.

According to the ISO 9000 standards, the control and testing are executed as long as the object is built, because it is the only way of a comprehensive and total control and a condition to build an object according to the contracted quality.

Both in the construction of a road-way structure as well as in the construction of whole road, just as in any production process, there is a certification of materials and the construction on its own. It contains the guarantee of the manufacturer of material and the construction executive (internal control) and the certification of an institution authorised for that (external control).

6. ROAD QUALITY ACCOMPLISHMENT

Achieving the required quality of the roads, comprises the accomplishment of all the production processes: the process of auction, contracting, designing, building, exploiting and maintaining the roads.

As opposed to some other industrial branches, in the civil engineering the designing and the production need not be realised within the same enterprise. Nevertheless, it is necessary that all the participants in the realisation of the roads work at accomplishing the final quality of the roads. The non-quality product (material, semi-manufactured product, product...) at any level effects to a certain extent a non-quality product at a higher level of production. That can make significant difficulties in the road quality accomplishment and bring about the delay in the realisation of the object itself, the increase of the built object price, misunderstandings and confrontations of the participants in the road building process...

To accomplish the road quality, the desired quality, methods and procedures for quantification of the quality of road construction should be precisely determined before-

hand. The quantification of the road construction quality is a problem in some cases and it is interesting for research and study.

The designer and the executive should prove that they have the cadre, the finances and the material means (tools, mechanisation, plants, equipment...) and that they can fulfill their obligations with no problems, and achieve the required quality of their products and the road in its entirety. When the conditions and the quality which ought to be fulfilled by the designer and the executive are in question, the same requirements stand for their sub-executives and sub-contractors. In order not to effect the decrease of quality, the supervising organ (design and investor supervising) observes the complete road production process and the simple processes and procedures pertaining to the production of the input material and semi-manufactured products (for instance pre-fabricated elements) with utmost carefulness.

7. ROAD QUALITY MANAGEMENT

The ISO 9000 standards give the instructions for the quality management and quality attaining depending on the selected model. The selection of the desired model depends on the required goal in the quality system. It is necessary that the quality management system be established by the investors, designers and the executives in the field of road construction. In addition, the inter-dependencies of the various activities in the area of road building, spoken of in the preceding text, should be taken into account.

It is important to emphasize that the procedure of the quality system development in the area of road building (the ISO 9000 standards) has began in many countries, and many apply the complete quality management system, while the most advanced countries use the TQM. Our country has not achieved the road building quality management, though the individual quality management is done in some areas, as it is the road-way quality management. Our not keeping abreast with the developed countries of the world is evident.

8. POSSIBLE DEVELOPMENT TENDENCIES

It is necessary for our civil engineering enterprises, including those dealing with the road building, to (if they have not done it yet) commence the introduction of the Quality Management Systems, primarily for the reasons of the increased efficacy of the production, but also in order to be competitive on the market. This is emphasized by the fact that the need for the introduction of the QMS is not a recommendation any more, but obligation. The same goes for the investors, designers, manufacturers of the construction material and the executives.

The application of the quality management at the road building will increase along with the application of the QMS which will be transformed into the TQM.

When the TQM introduction is in question, one should obey the following general rules, by the order of appearance:

- The education of the employees is necessary, familiarizing with the management system, its possibilities and expected results, as well as the positive effects for the enterprise and (with a special emphasis) for the employees (higher quality, higher competitiveness on the market, higher profit, higher security of the employees, ...). This, above all, comprises the change of habits, understanding and significance of quality.

- The introduction of the employees in to the new system of management starts from the top, from the managers, and then it gradually spreads to all the levels of an enterprise. In order to enable the introduction of the new management system, the forming of the teams and other organizational models, as well as the continuous engagement of the formal and informal leaders.
- Then follows the identification and the quantification of the losses in the enterprise, after which the managers and the expert teams attempt to eliminate all the unnecessary losses or reduce them into the acceptable limits, i.e. achieve the better quality result.
- All the employees should be motivated and interested in the accepting of the new way of work (the change of the organizational solutions, rules, procedures and behaviour). In this phase, the teams and experts for the improvement of business come into play. In order to motivate the individual for the new QMS, he has to accept the changes on a free-will basis, to be psychologically well-prepared for the changes, to have the support of the other parts of the organisation and to take an active part in the changes.
- The teams and the experts for the improvement engage on the expert training of the employees for the application and the improvement of the new QMS. The staff is trained how to improve their own work and working process in which they take part. Without the knowledge improvement there cannot be any higher quality system. The training is used for the change of opinion about the quality in an enterprise, and neither money nor time should be spared for it, it has to include all the employees in the enterprise, and the training is commenced when it really can be performed, because the partial training is of no use, and in some cases can do more harm than good.
- The project of introduction of the new level must contain all levels, with no exceptions, as all in an enterprise should understand and accept the new way of business. It is necessary that this project should have a formed managing structure, so as to intervene adequately and in good time in case of any departure from the realisation of the TQM project introduction.

9. TOTAL QUALITY MANAGEMENT INTRODUCTION

The total quality management introduction in the road building is a need and an obligation. The task should be approached as the introduction of the TQM in other enterprises, having respect to the specifics of the civil engineering enterprises which deal with the road building.

The basic thing in the introduction of the TQM is that there is no uniform recipe for that activity. However, there are widely accepted rules which should be obeyed in the practice. The TQM introduction usually goes through seven stages:

- The initial stage in the TQM introduction is the evaluation of the existing condition and the problems;
- Defining and introduction of the precise goals;
- Detailed study and analysis of the causes for the quality problems;

- On the basis of the previous stage, the detailed plans and programmes for the quality improvement are worked out;
- Execution of the needed and planned changes aimed at the quality introduction;
- Analysis and evaluation of the results of the executed changes;
- Continuous surveillance of the established new quality, through the observation, record and analysis of the established quality.

The beginning of a road building enterprise transformation and the beginning of the TQM introduction lies in the managers. The managers become the leaders (and not the controllers), establish the improvement programmes, establish the internal coordination processes (control, training and help in the quality improvement), take measures to change the organisational culture (which is a significant support in the quality improvement programmes), they are the advocates of training and education, promote the new quality management philosophy, motivate themselves and the employees in the realisation of the given programme, encourage the team work in the quality improvement but also in the other problems in business.

Notwithstanding the fact that the TQM from its introduction lies on the managers, it cannot be introduced or function without the support and the constant engagement of all the employed in an enterprise.

In order to successfully introduce the TQM in the road building enterprises, as well as in many other enterprises, it is necessary to start with the small number of problems, introduce the quality management in phases, explain the system of quality to the employees, simplify and improve the process and procedures, and shorten the time of execution with the optimum costs. It is not advisable to try to copy the already existing model of quality management, because each enterprise has its specifics and characteristics, so it is likely to face difficulties in copying. Each enterprise must define its own model, following the general principles of the TQM introduction in the process.

10. CONCLUSION

Among many definitions about the management, which are sometimes opposed to one another, the most realistic and acceptable is the P. Dusker's definition: " The management is the 20th century success story"[5]. This story will certainly be continued in the 21st century, we hope much more intense and with much more success in our parts. The management has the full prominence in the civil engineering, because building of the investment objects is one of the more creative human activities.

The management and the managers are indispensable to the civil engineering enterprises (as well as to the economy and society in its entirety), no efficient enterprise leadership or business is possible without them. Apart from the change in the management and professional managers introduction, the civil engineering enterprises need the program, market, organisational, cadre and financial changes; and it is a trait of the contemporary managers not to be content with the growth of their enterprises, but also with their intense development.

The TQM concept is wide-spread in all the field of life and work, and in several recent years it goes through a true expansion. This is a managing model which spreads in all the countries of the world, with great speed. A large number of the TQM models are in application, and it can be stated that each organisation has its own model.

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UPRAVLJANJE KVALITETOM PUTEVA**Milorad Zlatanović**

Izgradnja puteva je jedan od: najkompleksnijih proizvodnih procesa u građevinarstvu; najobimnijih po količini izvršenja radova; i najznačajnijih po obimu angažovanih finansijskih sredstava. Izgradnja takvog građevinskog objekta neminovno zahteva upravljanje kvalitetom. U radu se ukazuje na značaj, specifičnost i primenu upravljanja kvalitetom izgradnje puteva. Razlog više za uvođenje upravljanja kvalitetom izgradnje ovih investicionih objekata su značajni troškovi u sanaciji nekvalitetno izvedenog puta. Pored ovih direktnih troškova, javljaju se i indirektni troškovi nastali usled zakašnjenja izgradnje ovog građevinskog objekta. Kako su troškovi nedovoljnog kvaliteta izvedenog puta višestruko veći od troškova uvođenja sistema upravljanja kvalitetom, to je uvođenje upravljanja kvalitetom izgradnje puteva imperativ za planere, projektante, podizvođače i izvođače radova.

Ključne reči: *Saobraćajnice, upravljanje, kvalitet.*