An Approach To The Quality Improvement Of A Massive Investment Project By Integrating Ict And Qms

Tamara Gvozdenovic

Hydro Power Plants on the Trebišnjica, Trebinje, Republic of Srpska

Milan J. Perovic

University of Montenegro, Montenegro

Abstract: *This work has presented an approach to the quality improvement of an investment project by the change in the concept of project management. Building time of the investment project is a complex factor which needs a special attention. It is well known that the PERT method has been applied with long-lasting investment projects, where a big time distance brings about significant uncertainty of future situations. Microsoft Project 2002 and Matlab: Neural Network Toolbox are the softwear tools used for solving the problem of investment project management.*

Keywords: *Project management, PERT, Ms Project, Matlab: Neural Network Toolbox.*

1. INTRODUCTION

From the historical point of view, projects as well as a certain approach to the project management have existed for centuries. Monuments that have survived from the earliest times of human beings civilization give evidence of incredible achievements of human labour and they still cause our amazement and admiration. Some examples of projects in the distant and close past are: The Pharaohs` Pyramids, The Chinese Wall, The Eiffel Tower, The Suez Channel, The Tunnel under the English Channel, Manhattan Project, Apollo Program and some others.

Project management which we know nowadays started the development of first methods of network planning in 1950s. The appearance of personal computers and software for project management advanced the field of project management, and the application of the concept of project management and adequate methods and techniques were expanded. From the 1990s the concept of project management has obtained the forms which have been widely used and introduced as practice in project realization.

The increase of competition, rapid

technological development, growth of user's interests, shorter life cycle of products, corporate downsizing, and extended amount of information as well as other numerous changes caused a different approach to the method of work of the organization. Business organizations started applying and adapting the concept of project management as the way of implementing the changes and improving the whole process of business operations. Now project management is not a special need of management any more but it is a standard way of doing work.

The concept of project management is an approach to the realization of modern investment projects for controlling building time and costs. Information technologies are identified as a key to the investment integration and organization leading to the improvement of efficiency in the project and business operations.

2. PROJECT MANAGEMENT
2.1 The concept of project management

An efficient realization of a project is only

possible if it is done in an organized way, if all single processes are recognized and planned in detail and if all single activities and the realization of the project are coordinated and directed on the whole. Effects of the appliance of the concept of project management can be recognized in valuable time and financial savings and rationalizations which are obtained in the process of project realization, and they depend on the type of the project and characteristics of the process of the realization which is directed.

Project: unique process, consisting of a set of co-ordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements, including the constraints of time, cost and resources /12/.

Project management is the application of knowledge, skills, tools, and techniques to project activities to meet project requirements /1/.

The management of large projects involves three phases /10/:

- Planning. This phase includes goal setting, defining the project, and team organization.
- Scheduling. This phase relates people, money, and supplies to specific activities and relates activities to each other.
- Controling. Here the firm monitors resourses, costs, quality, and budgets. It also revises or changes plans and shifts resources to meet time and cost demands.

The global interest for project management has reflected through a line of international standards ISO 10006: "Quality Management: Guidelines to Quality in Project Management" and ISO 9000 (QMS).

The main aim of the project is to satisfy users` demands, while the main characteristics for all projects are: aim, time limit, complexity, extent and nature of the task, resources, and organization structure and information system. Basic elements of realization of all projects, which have to be planned, monitored and controlled, are time, resources and costs.

2.2 Project management techniques

The technique of network planning is a common idea for more methods which are used for planning the whole process of the realization of the project, monitoring and controlling the same process from time and cost point of view. These methods are based on the application of modern algebra, theory of graphs and maths statistics. The main advantage of this technique is that it separates time analysis from structure analysis and in that way it allows appliance of computers for time calculating of the beginning and end of some activities, time reserves, probability and a critical path while carrying out the project. A structure analysis includes the following tasks /11/ :

- Studying the project.
- Defining necessity activities (making a basic list of activities).
- Examining interdependence of activities.
- Constructing a network diagram of the project.
- Network diagram numbering.
- Controlling of the expressed network diagram.
- Making a list of activities.

The PERT method (Program Evaluation and Review Technique) is one of the original methods for network planning which is still used nowadays successfully for efficient managing of complex, long-lasting and expensive development and investment projects, where a big time distance brings about significant uncertainty of future situations.

Applying the technique of network planning, project managers can recognize possible problems, which can appear during the project, even before the start and also recognize critical activities which can have an impact on the final time limit of the whole task.

2.2.1 The time analysis according to the PERT method

The main aim of the time analysis is that the technology of bringing out the project, which is expressed by structure analysis, can get time dimension. In the case of investment projects, and based on the experience in similar projects, the duration of some single activities can be solidly estimated, as well as which activities can face difficulties and problems, that lead to the extension of needed time.

The PERT method operates with elements of probability, including three estimations of activity durations (a, m, b). The PERT method relies on stochastic approach and respects uncertainty of the future and impossibility for

T. Gvozdenovic, M. Perovic

the future situations and events to be exactly defined. In this method three different time values are defined for every single activity:

o a_{ij} - the optimistic time of certain activities shows the shortest time for bringing out some activities. The optimistic time is the time in which an activity will be brought out, in the case of ideal circumstances and without any difficulties.

o m_{ij} - the most likely (the most probable) time of bringing out the activities is the needed time for their realization under the normal circumstances.

o b_{ij} - the pessimistic time of bringing out the activities is the longest time for their realization in the most unfavourable conditions (apart from objective conditions which could not be predicted in advance and where the prediction would be illogical).

Based on the a_{ij}, m_{ij} and b_{ij} time for each activity, the calculation of the expected time of activity completion $(t_e)_{ij}$ and variance $(s^2)_{ij}$ is brought out in the framework of time analysis according to the PERT method.

Expected time of activity completion is calculated according to the following formula /15/:

$$(t_e)_{ij} = E(t) = \frac{a_{ij} + 4m_{ij} + b_{ij}}{6}$$

While variance of activity completion time shows a measure of uncertainty in activity completion time and is calculated according to the following formula /15/:

$$(s^2)_{ij} = \left(\frac{b_{ij} - a_{ij}}{6}\right)^2$$

During the time analysis the earliest and the latest time of event occurrence are determined. The earliest time of event occurrence shows the earliest deadline when a certain event can take place and it is marked with (T_E). The latest time of event occurrence (T_L) shows the latest deadline of event occurrence while the final deadline of the project end is not changed.

In the further time analysis according to the PERT method calculation of the slack time S is done, and it shows the difference between the earliest and the latest event occurrence and it is calculated according to the following model:

$$(S)_i = (T_L)_i - (T_E)_i, (i = 1, 2, \mathbf{K}, n).$$

The value of the slack time can be positive, negative or zero. Positive slack time points out to the existence of slack time and possibility of task completion before the expected time, i.e. there is capacity surplus in that work. Zero slack time shows that there is not any slack time and the capacities are adequate to planned needs. Negative slack time shows that there is not enough time for task completion, i.e. it shows capacity and assets deficit related to the planned ones and also shows the impossibility for the task completion in the planned time. Slack time determines in which degree a certain event can become critical.

3. REDUCTION OF THE PROJECT DURATION TIME

Duration of the object building is a very influential productive factor and in the course of time it becomes a factor of great significance.

Duration, as a significant parameter, is liable to changes, and it almost always causes changes in costs. This situation costs-time is focused on the reduction of critical path, which determines the project completion date. By working on the critical activities we can influence the project completion deadline. Quality is very often a compromise for achieving the final deadline. Time to market has got new significance during the past years because of the strong global competition and rapid technological development. Reduction of the project duration also appears in the case of unforeseen project extension, e.g. unfavourable weather, design errors, errors in the equipment etc. and all of these lead to the significant delay in the project realization. So returning to the schedule usually needs time compression on some of the remaining critical activities. In these situations it is important to compare expenses of returning the project to the schedule and expenses of project delay. Sometimes it is impossible to reduce duration on all these activities.

Reduction of the extent of the project is sometimes done for the scope of the reduction of the project duration. Sometimes it is possible

to rearrange project network logic so critical activities are done parallel. Time management is usually done by involving some additional resources on certain critical activities. Duration of most activities is connected with resource engagement, so if one job is done for 8 hours by one worker, the same job would be done for 4 hours by two workers with the same qualifications /7/. However, doubling the number of resources do not always results in reducing the time by half. Researches show that engaging additional resources in the project which is late make it more expensive. It is better to add human resources earlier in the project schedule, because newly engaged people cause an immediate negative effect on the progress and they need weeks to overcome difficulties.

4. PLANNING OF THE INVESTMENT PROJECT TIME REALIZATION

Because of the complexity of the time factors and based on the importance which the project of building the hydro-technical supply tunnel Fatnica field – Reservoir Bileća has for further investment it is obvious why building time management of this investment project is the subject of this paper.

A plan is a base for efficient and effective project management. Planning is a process of aim defining of the project realization and necessary activities for achieving it. Project realization planning procedure starts with time planning. There are a few kind of time planning such as global network plans, standard network plans, detailed network plans etc.

Time planning of the project realization includes /10/:

- q Activity defining.
- q Activity interdependence determination.
- q Examining of the duration of the activities.
- q Activity scheduling.

Programmed package MS Project 2002 has been used for time planning of this investment project. First of all work breakdown structure of this project has been done using WBS techniques on a few smaller logical areas.

A list of all activities, which this project consists of, has been entered into the Microsoft Project 2002. Established hierarchical relation has been presented through the summary task and interdependence of all activities has also been established (Figure 1). It is vitally important to enter correct and accurate data of interdependence among activities, as well as data of the type of interdependence, because they have a strong effect on time planning of the project. After project structure analysis completion and checking feasibility of the plan, time analysis was started.
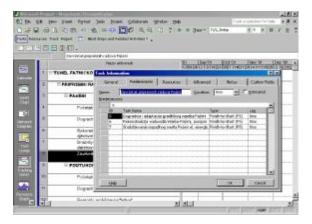

Figure 1. Dialog box for entering and displaying activity interdepedence

Calculation of the time is based on the data of interdependence between activities and their duration, as well as expenses data.

Since activities which should be done to realize the investment project contain specific characteristics, it is more convenient to use the PERT method for time analysis.

4.1 Time analysis using the PERT method

To determine optimistic, the most probable and pessimistic time we have used a simulation in program package Matlab: Neural Network Toolbox.

To carry out an experiment for training and testing the network two parameters were used as an input: optimistic and the most probable time, while as an output parameter we used pessimistic time. Input data were obtained from the expert estimation. During the training of the network and in the framework of the software package Matlab: Neural Network Toolbox the following elements were changed /9/:

- § Network type.
- § Network training function.
- § Weight studying function.
- § Performance function.
- § Number of layers.
- § Number of neurons in the layers.
- § Transfer function.
- § Number of epochs.
- § Desired accuracy.

Feed-forward backropagation network with parameters which are shown in the Figure 2 has been chosen.
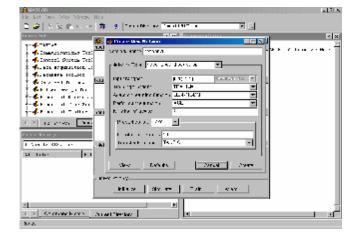

Figure 2. Feed-forward backpropagation network parameters

Matlab: Neutral Network Toolbox enables the application of the following transformation functions/5/:

- § PURELIN,
- § LOGSIG i
- § TANSIG.

The best results have been achieved:

- § using TANSIG function for the Layer 1 with 50 neurons and
- § using PURELIN function for the Layer 2 with 1 neuron.

The smallest errors have been obtained for 3903 epochs.

Table 1 shows experimental values of output for corresponding input, as well as errors made by neuron network training.

Table 1. Data obtained by network training

WBS	Input 1	Input 2	Output	Error	WBS	Input 1	Input 2	Output	Error
1.1.1.2	2,7	3	3,5	-0.0000	1.1.2.2	1,7	2	2,4	0.0000
1.1.2.3	3,5	4	4	-0.1750	1.2.1.1.1.2	1,6	2	2,1	-0.0833
1.2.1.1.2.2	1	1	1	-0.1667	1.2.1.2.1.2.2	0,8	1	1,1	0.0000
1.2.1.2.1.2.4	0,8	1	1,1	0.0000	1.2.1.2.2.2.2	2,8	3	3,1	-0.4130
1.2.1.2.2.2.3	0,6	1	1,5	0.0000	1.2.1.2.2.2.6	2,8	3	3,1	-0.4130
1.2.1.2.2.2.7	1,9	2	2,4	0.3200	1.2.1.2.2.3	3	3	3,5	0.3750
1.2.1.2.2.4.1	2,8	3	3,1	-0.4130	1.2.1.2.2.4.2	2,8	3	3,1	-0.4130

Trained network from the Figure 2 was used for the simulation of the rest of necessary data for the PERT method, which was given in the table 2.

Table 2. Simulated necessary data for the PERT method

WBS	Simulated output	WBS	Simulated output	WBS	Simulated output	WBS	Simulated output
1.1.1.3	2.1833	1.1.1.4	3.5	1.2.1.2.1.2.2	1.1	1.2.1.2.1.2.3	1.1
1.2.1.2.2.2.1	1.1667	1.2.1.2.2.2.4	3.513	1.2.1.2.2.2.5	2.08	1.2.1.2.2.2.8	3.513
1.2.1.2.2.4.3	3.513	1.2.1.2.2.4.4	3.513	1.2.1.2.2.4.6	3.513	1.2.1.2.2.4.7	3.513
1.2.1.2.2.4.9	3.513	1.2.1.2.2.5	3.513	1.2.1.2.2.6.2	3.513	1.2.1.2.2.6.4	3.513
1.2.1.2.2.6.5	3.513	1.2.1.2.3.2.2	0.35638	1.2.1.2.3.3.1	4.2	1.2.1.2.3.3.3	4.2
1.2.1.2.3.4.3	4.175	1.2.1.2.3.4.5	4.175	1.2.1.2.3.4.7	4.175	1.2.1.2.3.4.10	4.175
1.2.1.2.3.4.12	4.175	1.2.1.2.3.6.3	10	1.2.1.2.3.7.3	3.513	1.2.1.2.3.8	3.513

All necessary data for the PERT analysis has been collected on the base of the tables 1 and 2. The Microsoft Project 2002 table is shown in the Figure 3 with all necessary data needed for the PERT analysis, as well as with the estimation of the expected time duration which Microsoft Project 2002 calculates.
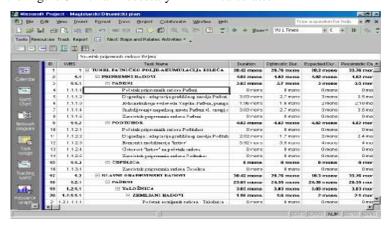

Figure 3. PERT analysis /9/

T. Gvozdenovic, M. Perovic

The date from the Figure 3 is used for the further analysis. Critical path shows the path from the first to the last event which has the longest duration. At the same time, that time duration shows the time needed for the project realization. All the activities on the critical path have zero slack time so all time movements of the critical activities influence the time duration of the project. And if the project manager wants the project to be finished in a shorter period of time, it is necessary to reduce one of critical activities. On the other hand, if we want to level resources, to enable the project to be done properly, reserves lie in the activities which are not critical. Their occurrence can be delayed for slack time, and in that way enable the project to be done without exceeding planned time of project completion. In the Figure 4 there is a tabular plan review with slack time.
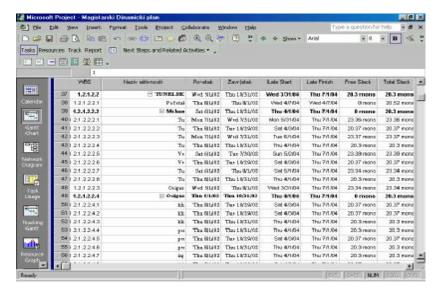

Figure 4. Activity fulfillment plan with slack time /9/

In the Figure 4 we can see that the activities, which total and free slack time value is big, can be moved for this slack time, and they do not influence the following activities and total time needed for project completion. In the case that some of the resources need to be leveled, these activities would be main candidates for moving, because resources engaged for them could be assigned to another activity where there are some defects, and not to exceed the previously planned project completion time.

When the plan is successfully made, project realization is assigned to professionals, while project manager monitors its realization. Therefore, the main prerequisite for successful project realization is a good plan.

In the case of investment project plan making, the plan shown in the Figure 3 shows the shortest project completion time, and if all necessary resources are at disposal, the project can be done according to this plan. But if the project manager wants to finish the project sooner, activities should be shortened on critical path. In this investment project there is a possibility to use resources which have slack time; due to it it is possible to finish

the project during the planned time without any additional expenses.

After the time planning process of the project realization, monitoring and control of the project realization time start. The main aim of monitoring and controlling the project realization time is to find out if project realization in the field is corresponds the plan, and if the whole project will be realized during the planned time.

5. CONCLUSION

Adjustment to modern business conditions needs fundamentally different work organization and business operations of organizations. Projects and project management are becoming a more important component in modern business conditions. Today the concept of project management is the best method for effective investment project management. Project management is a modern multidiscipline concept which became a legal base in well developed countries, standardized and included in ISO 9000.

This work has presented time planning of investment project realization. Time is one of basic criteria for investment project evaluation. In the dynamic environment, where the projects are done, project managers have to be prepared to act quickly and effectively. If the plan is well done, success is inevitable.

REFERENCES:

[1] ANSI/PMI 99-001-2000 Project Management Institute, "*A Guide to the Project Management Body of Knowledge (PMBOK Guide)*", Inc. Pennsylvania, USA 2000. (english language)

[2] Chatfield C., Johnson T., *"Microsoft Project Version 2002 Step by Step"*, CET Computer Equipment and Trade, Beograd 2002. (serbian language)

[3] Courter G., Marquis A., "*Project 2000*", Kompjuterska biblioteka Syber, Čačak 2002. (serbian language)

[4] Ćalasan L., Petkovska M., *"Matlab i dodatni moduli Control System Toolbox i Symulink"*, Mikro knjiga, Beograd 1995. (serbian language)

[5] Demuth H., Beale M., *"Neural Network Toolbox For Use with Matlab"*, The MathWorks, 2000.

[6] Dinsmore C. P., Cabanis-Brewin J., *"The AMA Handbook of Project Management"*, American Management Association, New York, 2006. (english language)

[7] Gray F. C., Larson W. E., "*Project Management – The Managerial Process*", Oregon State University 2000. (english language)

[8] Goodpasture J., *"Quantitative Methods in Project Management",* J. Ross Publishing, Florida 2004. (english language)

[9] Gvozdenović T., "*Upravljanje projektom preko vremena u CIPR/CIE ambijentu*", M.Sc thesis, Production and management faculty, Trebinje 2004. (serbian language)

[10] Heizer J., Render B., "*Operations Management",* Prentice Hall, New Jersey, 2001. (english language)

[11] Jovanović P., "*Upravljanje projektom*", Grafoslog, Beograd 2002. (serbian language)

[12] JUS ISO 10006:1997., "Menadžment kvalitetom – Uputstvo za kvalitet menadžmenta projektom" (serbian language)

[13] Meredith J., Mantel S., "*Project management – A Managerial Approach*", John Wiley & Sons.Inc., New York 1995. (english language)

[14] Murch R., *"Project Management – Best Practices for IT Professionals"*, Prentice-Hall, USA 2001. (english language)

[15] Petrić J., "*Operaciona istraživanja*", Nauka, Beograd 1997. (serbian language)