Global Journal of Researches in Engineering
Civil And Structural Engineering
Volume 12 Issue 4 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Controlling Slippage in Water Resources and Infrastructure Projects

By Debabrata Kar
Institution of Civil Engineers-Country Representative, Eastern India.

Synopsis- Slippage of projects particularly in the water and infrastructure sector is a common occurrence. The activity networking techniques initiated in the USA in the 1950s gained large popularity. This was followed by introduction of computer and numerous software on network analysis aiming at effective project control. While these techniques are helpful the real problem of controlling the project slippage still remains largely unsolved. The author is involved in further research in this area. It is felt that arresting project slippage would be largely possible with improvisation and innovation of the techniques already in use. The shortcomings are not so much on the available methods but on their effective application to derive the desired result. An effective control comes from the management process – the individuals, the team and the implementation of proper controls and procedures.

GJRE-E Classification : FOR Code: 090509

CONTROLLING SLIPPAGE IN WATER RESOURCES AND INFRASTRUCTURE PROJECTS

Strictly as per the compliance and regulations of :

Controlling Slippage in Water Resources and Infrastructure Projects

Debabrata Kar

Synopsis - Slippage of projects particularly in the water and infrastructure sector is a common occurrence. The activity networking techniques initiated in the USA in the 1950s gained large popularity. This was followed by introduction of computer and numerous software on network analysis aiming at effective project control. While these techniques are helpful the real problem of controlling the project slippage still remains largely unsolved. The author is involved in further research in this area. It is felt that arresting project slippage would be largely possible with improvisation and innovation of the techniques already in use. The shortcomings are not so much on the available methods but on their effective application to derive the desired result. An effective control comes from the management process – the individuals, the team and the implementation of proper controls and procedures.

I. Project Planning And Implementation

Planning and implementation of water resources and infrastructure projects have been considered under major groups like, surface water projects, ground water projects, projects on storm water drainage, sewage and effluent treatment and projects on protection of the environment and preservation of the ecological system. In addition, other projects on infrastructure development have been considered.

a) Surface Water Projects

Surface water projects involve dams and hydroelectric projects, multipurpose river valley projects; barrage, canals and head works, water intake, treatment and water supply network, dredging, embankment protection and river training, sea water desalination and distribution etc. Planning of these projects involve locating the source and the possible yield and its reliability and sustainability, choosing the process and the route, assessing the availability of required land, land acquisition keeping in view existing farm land, existing villages and other human habitation, existing flora and fauna, effect on the environment etc.

While care should be taken to avoid farm land, exiting villages, etc. it may not be possible in many situations. Relief and rehabilitation to the project affected people including providing alternative employment to them is a priority. Implementation should be suitably phases out to meet the construction schedule causing least inconvenience to the general public, at the same time, safeguarding the environment.

b) Ground Water Projects

Groundwater constitutes an integral part of the overall hydrological system. Water, the earth's most precious natural resources, is the most exploited and grossly misused resource. To mitigate the ever increasing demand for clean water people largely depend on groundwater which is being pumped out at an alarming rate causing lowering of sub-soil water table. The recharging of the aquifer by rainfall and natural infiltration does not compensate for the excessive withdrawal. In addition this drop in water table results in intrusion of arsenic, other harmful minerals salts and saline water in coastal areas. In addition this causes large scale subsidence of the ground. The solution lies in controlling the withdrawal of groundwater and ensuring adequate recharging of the aquifer with fresh water.

The planning of a groundwater project must be done considering the overall water scenario of the surrounding taking into account the draw down of the water table and the circle of influence. One consideration should be on the topography of the surface, density of population, prevailing plant and vegetation, existing structures, nature of surface and sub-surface soil strata, with particular reference to its porosity, permeability, prevalence of clay, sand and silt, rock and other impervious strata with corresponding degree of weathering.

These projects may be grouped under : Groundwater exploration and conservation; rain water harvesting; recharging of aquifer to raise the sub-soil water table; prevention of groundwater contamination and protection against groundwater pollution; protection against arsenic and saline water intrusion; prevention of water table lowering; and preventing the possibility to large scale land subsidence.

c) Sewage Treatment and Environment Protection

These projects introduce faecal sewage treatment plants, effluent treatment plants, recycling of treated sewage/effluent and storm water drainage systems. Projects on protection of the environment include solid waste disposal, disposal of hospital and medical waste, disposal of radio active waste and used isotopes.

Author : PhD, FICE, F.ASCE, FIE-Ind, Institution of Civil Engineers-Country Representative, Eastern India, Mentor, American Society of Civil Engineers-India Section.

Storm water drainage projects should ensure that the water flows by gravity and self cleansing velocity of flow is maintained to minimise additional cleaning efforts. Similar consideration holds good for sewage and effluent treatment plants so that installation of additional booster pumps may not be necessary.

d) Other Infrastructure Projects

Some of the broad items in infrastructure may be – Building and housing; Highways, Roads, Railways, Bridges, Tunnels; Power Generation and Distribution; Hospitals and Health Centres; Universities and Educational Institutions; Hotels and Hospitality Centres; Markets and Shopping Malls; Entertainment Centres and Multiplexes; IT and Digital Communication. In general infrastructure covers all facilities and services for the use and benefit of the people in general which supports public life but are outside the scope of the main manufacturing process. Planning and implementation of these facilities have to be done keeping in mind the ultimate beneficiary, i.e., the general public.

II. Causes Of Project Slippage

There are many possible causes of project slippage some of which are common in most projects. Some causes are special in case of projects relating to development of water resources and infrastructure. Project slippage is also frequent in developing countries as compared to the developed world. In most real life project situations multiple causes occur simultaneously. Some researchers call this concurrent delay syndrome. Many of these causes are intervention and inter-dependent and may be in engineering and/or in management. The major causes may be summarized as follows :

- Planning : Many projects on water and infrastructure are taken up without enough home work or in depth planning.
- Change : As a result of lack of sufficient detailed planning in advance the water and infrastructure projects are subjected to frequent and substantial change in the course of implementation.
- Poor Management : Many of such projects suffer delay due to lapses in management.
- Scheduling : Initial schedule sometimes is very tight with a view to promise early completion. Such schedules do not take into account the ground realities and are unrealistic.
- Management Support : Efficient management and timely completion is possible only with the full cooperation and support from the top management.
- Funding : Regular and smooth cash flow is a must and is an essential requirement to make the project progressing in conformity with the schedule.
- Cost Contaminant : Cost overrun is a frequent cause of slippage in water and infrastructure projects.
- Resources : For the project success and its completion on schedule optimum resources – men, material, machinery and money must be made available at all stages.
- Information Management : Lack of accurate and timely feed back and poor coordination and communication are causes of project failure in the water and infrastructure sector.
- Incentives : Project success depends largely on effective deployment of the human resources and getting the best output to benefit the project. Workers motivation through incentives is a major aspect in achieving project success.
- Risk Analysis : Many projects in water and infrastructure sector are taken up without a prior in-depth assessment of the consequent risk involved.
- Total Involvement : Involvement of the Government, the community and all the stakeholders are significant factors in achieve project success. The legal support and the political will to make it happen is no less important.

The delaying factors may be put under two main categories, i.e., internal and external.

Internal Factors : These are causes which are somewhat within the control of the project authorities.

- Non-acquisition of project site and access to site
- Clearance to start work from local authorities
- Project funding and mobilisation of resources
- Improper contracting due to strict compliance with rules
- Consultants' lapses in providing drawings and documents in time
- Contractors' lapses in delaying the start and shortcomings on mobilisation of materials, equipment, workforce at site.
- Lapses in identifying key problem areas.
- Delayed decision on corrective action and its timely implementation.
- Lapses in issues relating to health, safety and environment.
- Contractors' low productivity and poor performance.
- External Factors: These are causes which are by and large beyond the control of the project authorities :
- Act of God, Force Majeure
- Natural calamities like heavy rain, cloud burst, unprecedented storm, flood, high intensity earthquake, tsunami and other natural calamities.
- New legislation enacted by the Central or State Government.
- Power and Water Supply Failure.

Global Journal of Researches in Engineering (E) Volume XII Issue IV Version I Year 2012

- Famine and outbreak of epidemic.
- Labour unrest, strike, lockout, etc.
- Local festival causing large scale absenteeism

Although the external factors, are beyond the control of the project authorities, the consequent impact may be minimised by re-sequencing of project phases and re-arranging the order of priorities in implementation.

The engineering aspects leading to project delay may include design lapses, improper detailing, interference of facilities and services, emergence of unforeseen obstruction at site, etc.

III. Methodology For Arresting Project Slippage

Slippage is causes by delays at various stages causes by one or more problems. Hence, the root cause is the problem which has to be identified in advance and pro-active action taken to eliminate it. The suggested approach is identifying the problems, analysing the causes, quantifying the slippages, evaluating the overall impact on the project and taking appropriate remedial measures. The project response to the corrective action applied has to be measured on a continuous basis. In case of unsatisfactory project response, revised strategy has to be evolved and applied to achieve best result. Proven time tested techniques are suggested including application of proven project management software. Effective result can be achieved by improvisation and innovation at all stages. Reliable and accurate feedback information and total involvement of all concerned is important. Shortening the time for data processing and transmittal is equality important. This can be achieved through the optimum utilisation of state-of-the-art IT and telecommunication technology, advanced mechanised construction and application of automation and robotics in construction wherever applicable.

a) *Critical Path Method (CPM)*

CPM is the most widely used scheduling technique. Both CPM and the Programme Evaluation and Review Technique (PERT) were initiated in the USA about fifty years back and are in use all over the world. Computer programmes and algorithms for CPM and PERT are widely available. There are two forms of presentation namely, Activity on Arrow (AOA), Activity Oriented Network and Activity On Node (AON), Event Oriented Network.

b) *Precedence Diagramming Method (PDM)*

The precedence diagram is a modified form of event oriented network (AON) where the events are in rectangular boxes and the logical sequence of occurrence is represented in the following four basic relationships between the predecessor and successor activities :

- Finish to Start (FS) – The successor activity (S) cannot start unless the predecessor activity (P) is completed P → S.
- Start to Start (SS) – The success activity P → S cannot start until the predecessor activity has been started.
- Finish to Finish (FF) – The successor activity P → S cannot finish until the predecessor activity has been finished.
- Start to Finish (SF) – The successor activity P → S cannot finish until the predecessor activity has been started.

Eight separate categories of precedence constraints can be defined, representing greater than (Lead) or less than (Lag) time constraints. These relationships are: FS Lead, FS Lag, SS Lead, SS Lag; FF Lead, FF Lag, SF Lead, SF Lag.

c) *Time Estimate*

In estimating the activity duration there are normally two approaches – deterministic and probabilistic. CPM takes into account single time estimate based on past experience and historical record on similar projects. PERT was developed on research projects where the activity durations could not be estimated with certainty. Hence, a statistical method based on probability was adopted. The pattern of distribution considered was 'β' distribution which has been simplified for practical application as the three time estimate. Hence, for all practical purposes the time estimate are – Single Time Estimate for CPM and Three Time Estimate for PERT.

The algorithm for the probabilistic time estimate for an activity (i, j) is, Optimistic time estimate $= a$; Most likely time estimate $= m$ and Pessimistic time estimate $= b$ Activity duration μ (i, j) based on β distribution would be, $\mu(i,j) = \dfrac{a+4m+b}{6}$ while there are more complex statistical formulae for probabilistic time estimate the three time estimate based on β distribution is widely used.

d) *Data Collection, Assembly and Feed-Back*

The reliability of the basic project planning, scheduling and the monitoring and control depends a lot on the data fed into the system and the subsequent

Global Journal of Researches in Engineering (E) Volume XII Issue IV Version I Year 2012

feedback information. The data must be realistic based on spot investigation, official record from concerned authorities and historical record on past projects.

e) Work Breakdown Structure (WBS)

The WBS is a basic technique of breaking down the total scope of the project into manageable work packages and further detailed activities to facilitate detailed planning. The logical sequence of activities need not be considered at this stage however, responsibilities are to be assigned to help evaluate the possible number of work packages and develop a proper Organization Breakdown Structure (OBS). It should be an essential first step in developing the activity network. WBS can be organised into a logical sequence to develop a network schedule. It is desirable to develop a flexible WBS that can be modified with changing project situation.

f) Network Formulation, Stabilisation and Updating

The flow charts in Fig.1 shows the steps involved in formulation and stabilisation of the network and issuing the initial report for follow-up. Fig.2 shows by a flow chart the project updating cycle. This is a repetitive operation during project monitoring and evaluation. The updating interval has to be decided carefully to effect adequate project control.

g) Project Risk Analysis

The economic viability of the project must be assessed in the beginning with reasonable degree of certainly. The following questions should be asked and satisfactory answers obtained:

Why take the risk on this project? What will be gained by implementing this project? What could be lost by taking up this project? What are the chances of success or failure on this project? What can be done if the desired result is not achieved? Is the potential reward from this project worth the risk being taken?

Every project has a risk. The degree of risk and the corresponding possibility of success should be assessed. Most water and infrastructure projects are justified from the consideration of long term social benefit rather than aspects of immediate commercial profitability.

h) Project Slippage Control

The flow chart in Fig.3 shows the Major Steps in Delay Management and Outlines the overall control system. The main action points to be specially attended to are:

* Delay Identification : Determining which delays are likely to affect the project and documenting the characteristics of each.
* Delay Quantification : Evaluating the effect of each delay and assessing its overall influence on the project.
* Delay Analysis : Identifying the problems causing the delays and breaking down the delays caused by each problem.
* Problem Analysis : Analysing the delay causing problems and ascertaining possible corrective actions to assess the impact of the delay on the project.
* Corrective Action : Application of remedial measures, evaluating how the project is responding to the corrective actions; deciding and applying revised actions in due time.

IV. Quality Assurance And Quality Control (QA/QC)

Quality Assurance (QA) and Quality Control (QC) are synonymous in nature. QA signifies all activities implemented within the quality system and demonstrated as needed, to provide confidence that services rendered will fulfil the requirements of quality. QC includes all activities and operational techniques that are used to fulfil the requirements for quality. Strict adherence to QA/QC is essential for achieving success in all construction projects.

In the recent past International Standards Organization (ISO), a worldwide federation of national standards bodies have issued ISO 9000 series of standards which are accepted internationally. In conformity with ISO 9000 international standards the Bureau of Indian Standards (BIS) have issued corresponding Indian Standards under series IS 14,000 which are applicable to construction and other activities in India.

V. Environment, Health And Safety

Execution of a construction project with due care of the environment, and health and free of accidents should be a clear objective for all concerned. Even in developed countries like the UK and USA construction is the most hazardous industry. The situation is much worse in developing countries. In India a number of codes on safety in construction have been brought out by the Bureau of Indian Standards (BIS) and other authorities. Unfortunately, a large part of the construction particularly in the water and infrastructure sector is carried out by the unorganised sector securing orders primarily on price consideration. In many projects the contractor's technical capability and past record on environment, health and safety is not a prime consideration for placement of order. Environment, health and safety should be the composite responsibility of all agencies involved in the construction project – the planner, the designer, the consultants, the project authority, the contractor and above all the workmen themselves.

VI. Human Aspects And Public Awareness

All projects on water resources and infrastructure are primarily to serve the people in general. So, the common people must be taken into full confidence right from day one and the work executed in full transparency. In countries like India with high density of population any project will involve acquisition of substantial privately owned land. It is natural that many people will be displaced from their age old homes, many farm land will be occupied, many wild animals will need to be re-located. Apart from a large scale social problem execution of large water and infrastructure projects create associated environmental problems as well. Political and legal involvement is a natural consequence in these projects.

Largely hydroelectric project is a good option to sold India's chronic power shortage. It is non-polluting and the energy source is renewable. But this involves construction of large dams leading to creation of large reservoirs inundating villages, towns, forests, etc. Because of the social, environmental, political and legal problems construction of large dams has virtually stopped in India. Considering large scale irrigation canal systems, inter-linking of rivers, large inter-state highways and railways which are cross-country and at times cross-border involving several neighbouring countries. Interaction with the project affected people and political negotia-tion and advance agreement is essential before signalling the go-ahead. The problem is complex in all countries but in densely populated India the problem has a special dimension. Development has a price which must be paid by way of temporary hardship and inconvenience to the project affected people for the long term social benefit to the nation.

VII. Case Studies

The research shows that the proposed model should be within the broad framework of the time tested network analysis technique. Attempts should be made to reach perfection in the basic inputs to the project on planning. The authors have substantiated the proposed innovative methodology on the following projects.

a) Water, Infrastructure and Services for SIDOR Steel Plant, Venezuela (1975-1980)

The project relates to PLAN IV Expansion of Venezuela's only state owned integrated steelworks at Matanzas with an investment of US$ 5 Billion involving large scale water resource and infrastructure development. The planning methodology adopted was activity networks (PDM) for data processing using IBM370 mainframe computer with IBM-PROJACS Control System. This construction was completed in about four years as planned without any significant time overrun and within approved budget. A photograph of the SIDOR Project-Water and Infrastructure facilities is shown in Fig.4.

b) Water, Power and Outdoor Facilities for Misurata Steel Complex, Libya (1983-1988)

The plant with an investment of US$ 5.5 Billion is situated on the Mediterranean coast close to Misurata City. Desalinated sea water was used for plant construction and operation. A central water station was provided for circulating the cooling and emergency water. Extensive yard facilities were also provided – project monitoring was done through activity networking in three categories. Computerised data processing was done through packages like IBM PROJACS, K&H and ARTEMIS. Commissioning of water and other infrastructures were completed on schedule. A photograph of the Misurata Steel Complex underground yard piping is shown in Fig.5.

c) Infrastructure, Water and Services for Salem Steel Plant – Phase II Expansion (1989-1991)

This project is Tamil Nadu, India was completed well ahead of schedule. The morale boosting achievement was a lesson useful for implementation of future projects. Slippages were arrested by timely corrective action and minimising consequential delays. Computerised CPM monitoring technique was adopted. The factors contributing to this achievement are:

Excellent Performance by all agencies : Meticulous planning and timely action in advance; vigorous project monitoring and follow-up; timely management intervention; excellent cooperation and team spirit.

d) Water Supply Project for Vikram Ispat Sponge Iron Plant, Raygad, Maharashtra, India (1991-1992)

The project involved supplying water from River Kundlika to the plant through a 500 mm dia, 40 km long pipeline. The pipes were of pre cast pre-stressed concrete in most parts and of MS in some parts. The project was planned in great details using the activity networking technique and rigorously followed up with close interaction with all agencies. The project was completed within the targeted schedule and within approved budget.

e) Water, Utilities and Services for Whirlpool Refrigerator Plant, Pune, India (1997-98)

The project infrastructure involved, Roads and Pavements, Storm Water Drainage, Raw Water Storage, Treated Water Storage, implementation was closely followed up through computerised network scheduling and close monitoring and follow-up. The key to success was a dedicated project team, total involvement and commitment of all concerned, excellent top management support, total focus on timely completion and fast decision, coordination and communication. All infrastructure and services were made ready in good time.

f) Orissa Water Resource Consolidation Project, India [OWRCP] (1998-2001)

OWRCP was a World Bank funded project to establish multi sectoral water planning, enhance the efficiency of public expenditures and, provide more efficient and effective irrigation services. The work was carried out by DOWR with technical assistance of a group of international and national consultants. Monitoring plan for the project components were developed with application of standard management software. A special software MEMIS (Monitoring and Evaluation Management Information System) was also developed. The project components on which the computerised monitoring plan was adopted successfully included Naraj Barrage Projects, Sakkhigopal Branch Canal System and Baghua Stage II Earth Dam Project.

VIII. Conclusion

The conclusion of this research work may be outlined as follows :

- Project slippage is a common occurrence. The projects relating to water resource and infrastructure sector in particular gives rise to some special problems.
- Delay in planning and implementation of projects may be caused due to several internal or external reasons. Introducing a system of recording delays on a day to day basis through a Delay Log Book is very effective.
- The methodology proposed in this paper for arresting project slippage is based on sufficient improvement and improvisation of the techniques which are already being used globally.
- The suggested approach is identifying the problem, analysing the causes, quantifying the slippages, evaluating the overall impact, and taking appropriate remedial measures.
- Due care should be taken for QA/QC, environment, health and safety, human aspects and public awareness.
- The proposed method reported herein was applied in SIX real life projects in water resource and infrastructure sector and adequate success was observed in controlling the slippage.

References Références Referencias

1. Kar, D. (2007). “An Innovative Methodology for Arresting Project Slippage in Water Resource and Infrastructural Project”, Synopsis of Ph.D. Thesis submitted to BESU, Howrah, India.
2. Kar, D. (2006). “Slippage in Implementation of Water Resources Development Projects in India-Causes and Remedies” – ASCE/IIT-Kanpur/EWRI, International Conference in New Delhi; Dec 2006.
3. Kar, D., Basak, S. and Bhattacharya, A.K. (2005). “Analysis and Control of Slippage in Water Resources Development Projects” – 20th Indian Engineering Congress of IEI, Kolkata, December 2005.