Project Management:  
A Survey of Current Practices and Implications

M G Korgaonker

In completing a large project there is a time overrun of the order of three years on a scheduled project duration of 3.7 years and a cost overrun of 140 per cent. Production losses are five times the cost overrun due to delay. Cost and time overruns are jeopardizing the viability of the projects themselves.

M G Korgaonker reviews and analyses the Indian experience as to why there are such heavy overruns. Based on a survey of current practices in project management, he concludes that project management practices can be improved considerably. He cites instances where effective management practices have led to completion of projects as per plans.

He draws implications of his analysis for the pre-investment investigation, project appraisal, organization, and implementation stages of project management.

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Projects are the vital means of development and economic upliftment. They are the building blocks for generating additional capital and for ensuring flow of goods and services to the nation. In India, large amounts have been and are being spent on various projects for providing infrastructural facilities and for meeting developmental needs. In the public sector alone, over Rs 30,000 crore have been invested in more than 200 projects. Unfortunately there have been considerable time and cost overruns in most of these projects. Tardy implementation has been a major cause for overruns. In some cases, implementation delays have had an adverse impact on the viability of the projects themselves.

In this paper, I have attempted a systematic analysis of the Indian experience in project management, particularly in the public sector. The public sector experience is particularly relevant for it is based on some of the most complex and massive projects India has undertaken. An analysis of the main causes for time and cost overruns is provided separately in Box 1 under the title "The Project Management Problem" below.

The main problem is time and cost overrun. Studies show that in a large public sector project the time overrun is of the order of about 3 years on a scheduled project duration of about 3.7 years. Cost overrun is about 140 per cent of the projected costs. Production losses due to delay in completion is five times the cost overrun due to delay.

This experience in project management raises several important questions:

- Is the repeated failure in the public sector to complete projects on time because of paucity of well conceived projects, or poor implementation, or both?
- To what extent is government policy on expansion, investment, and personnel recruitment responsible for the time and cost overruns?
- Are there major infrastructural or other
Box 1

The Project Management Problem

The major problem in project management is over-run—in time and cost. The causes are many and their impact on project profitability is highly adverse. Based on the findings of several studies on the subject, I briefly outline the nature and magnitude of time and cost overruns.

A study by Tripathy (1982) reveals that only 5 of the 49 public sector projects, each costing over Rs 20 crore and expected to be commissioned during 1974-79, were completed on time. Only two were completed within the project cost. The time and cost overruns for these 49 projects are shown in Table A. The average time delay was around five years and the average cost overrun was around 100 per cent.

Kapur (1983) provides data on specific projects in the power, steel, petroleum, irrigation, and mining sectors. These sectors are capital intensive and account for over 40 per cent of the total plan outlay in the public sector. The data are given in Table B. Kapur’s data show that the average time overrun on selected large projects in the core sector was nearly 3.5 years, close to the findings of the Tripathy study. The average cost overrun per month of delay was Rs 3.1 crore. The average production loss per month of delay was Rs 15.6 crore, i.e., nearly Rs 60 lakh per day. The production loss per unit time of delay was five times the cost overrun.

Kharbanda (1983) provides data on cost and time overruns in the case of 15 fertilizer projects (Table C). On an average the actual completion time was about 7 years—1.9 times the scheduled duration of 3.7 years—and actual costs were 2.4 times the planned costs. The cost overrun per month of delay was Rs 2.1 crore.

Why the Overruns? The sequence of hurdles in the life of a project is illustrated by the Korba fertilizer plant (Table D). Table E gives a summary of the main causes of time and cost overruns in fertilizer plants.

The main reasons for delays and cost overruns in fertilizer plants are the following:

- equipment-related—failures, late deliveries
- bottlenecks that come in the way of timely implementation?

To answer these questions, it is important to understand the stages in the life of a project and the state of project management practice in India at each stage. This is discussed below. A brief explanation of some of the terms used in project management is given in Box 2.

Life Cycle of a Project

Project management practice is best studied under the context of its life cycle. A possible project life cycle is outlined in Table 1 (Desai, 1983).

Table 1: A Typical Project Life Cycle

<table>
<thead>
<tr>
<th>Stage</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Investment</td>
<td>Report of working group on the sector for the national five-year plan. Ad-hoc committees and pre-feasibility studies.</td>
</tr>
<tr>
<td>Formulation</td>
<td>Feasibility reports on revised estimates and memorandum for Board of Directors/Ministry/Expenditure Finance Committee EFC/Public Investment Board (PIB)</td>
</tr>
<tr>
<td>Appraisal</td>
<td>Appraisal notes and comments of the scrutinizing agencies</td>
</tr>
<tr>
<td>Sanction</td>
<td>Minutes of PIB meetings, cabinet notes, and sanction order</td>
</tr>
<tr>
<td>Implementation</td>
<td>Detailed Project Report (DPR) and tender documents</td>
</tr>
<tr>
<td>Engineering</td>
<td>Monitoring reports and minutes of actual plan discussions</td>
</tr>
<tr>
<td>Completion</td>
<td>Completion report</td>
</tr>
<tr>
<td>Operation</td>
<td>Performance review reports and public enterprise survey</td>
</tr>
</tbody>
</table>

It will be useful to have an overview of the practices involved in pre-investment and implementation stages.

Pre-Investment Stage

Desai (1983) and Krishna (1983) provide a good description of the details of the pre-investment stage. The effectiveness of the pre-investment stage has
to be judged in terms of the correctness of the investment decision and the time taken to arrive at the decision. This stage involves several agencies:

- implementing organization which may be a non-departmental or departmental enterprise
- the controlling ministry
- linked sectoral ministries'
- Planning Commission
- Ministry of Finance
- Bureau of Public Enterprises
- Public Investment Board.

**Project Identification.** How are projects identified? Presently this involves studying:

- imports
- substitutes
- available local raw material
- available technology and skills
- inter-industry relationships
- existing industry
- development plans
- old projects.

However, these studies are not detailed. Projects are identified more as a 'shopping list' by the administrative agencies. The concern is more to justify the project rather than to meet the demand for goods and services. The capability required to plan a project is not available. Often there is a paucity of alternative projects. Many parameters such as shadow wage rate, accounting ratios, and premium on foreign exchange that are required for conducting a social cost benefit analysis are not available at the time of project identification.

The inclusion of a project in the five year plan is merely a statement of intent rather than a definite decision. The process of interministerial consultation which forms a part of the identification stage is very time consuming. Procedures for the pre-feasibility stage are not clear. Nor is there a forum for considering the results of pre-feasibility studies. For a long time there were also no guidelines for project formulation.

To assist in the preparation of feasibility reports, the following steps have been taken:

- A manual of feasibility report was prepared in 1965 by the Planning Commission with the assistance of USAID.
- A Project Appraisal Division was set up in the Planning Commission. The Division

- plan-related—low estimates, changes in scope, revisions of specifications, delays in finalizing financing patterns, completing formalities
- administrative—delays in approvals
- others—faulty engineering, piling, heavy rains, inferior pyrites.

Equipment-related problems were cited the most—nearly 40 per cent of the time. Inadequate provision in the feasibility report of the project is another important reason (Gupta, 1983). For example, in the Barauni fertilizer project, the government advised the erstwhile Fertilizer Corporation of India to modify the feasibility report and provide for an identical plan with naptha instead of fuel oil as feedstock. The proposal had to be modified. Gupta has estimated cost overruns due to inadequacy of the Total Estimate of Feasibility Report (TEFR) for some fertilizer plants. Inadequacy in the provision alone accounted for nearly 21 per cent of the cost overrun. Table F gives the cost overrun due to inadequate provision in the feasibility report.

**What Is the Cost of Delay?** Table G provides data of the Federation of Indian Chambers of Commerce and Industry (FICCI) (Naik, 1983). The cost per month of delay was Rs 0.7 crore and the average delay in completion was about 2.5 years. State governments have been losing nearly Rs 430 crore per year on their investment due to delays in irrigation projects.

To sum up, there is on the average a time overrun of over three years or nearly 90 per cent of the scheduled project duration. The cost overrun is about 140 per cent, amounting to Rs 2 crore per month's delay. Production losses due to delay were nearly five times the cost overrun. Needless to say, cost and time overruns seriously affect project profitability. For example, it has been found in the case of large ammonia plants (capacity 1200 T/day) that a year's delay in project completion drives the breakeven point four years into the future, jeopardizing its profitability for many years (Kharbanda, 1983).
Activity Times. The estimate of time required to perform an activity in a project is called activity time. In repetitive projects, data on time actually taken for an activity are available. In such cases, a single estimate of the activity time, such as the average time taken, may be adequate. This is a deterministic estimate of the activity time. In non-repetitive projects and activities there is a degree of uncertainty associated with any estimate of the activity time. In such cases, two or three activity time estimates are used. From such multiple estimates, we can assess the uncertainty associated with activity and project completion times.

Activity time data need to be updated periodically, taking into account the progress achieved, resources required for the remaining part of the activity, the resources available for completion, and changes, if any, in the priority for the activity.

Project Objectives. Typical objectives of a project are to complete the project:

- within a targeted time
- at or below a projected cost
- as per a specified quality level.

The degree of emphasis on any one of these objectives will change depending upon the nature of the project. In projects involving productive activity, large capital outlay, and long gestation period, costs of time delays are high, especially because of production losses and inflation in capital cost of the project. As a result, the project viability itself can be irretrievably jeopardized. In such cases, the emphasis is clearly on completing the project within the stipulated time. In some projects, completion dates are rigid and unalterable, such as construction of sports complexes. Here completion time gets the highest priority. In contrast, in large-scale housing construction the focus is much more on cost control. At any rate, it is important to define the project objectives as precisely as possible, and to review them from time to time.

Project Scheduling. Project scheduling is the preparation of schedules for performing various activities of a project.

Project Formulation. Despite these guidelines, project formulation by public sector units has not been a successful experience. Project formulation, as such, is the function of the administrative ministry which gets the work done through one of the public sector undertakings under its charge. The problems at this stage appear to be the following:

- There is a large degree of error in estimating the capital cost, particularly tending to underestimation. Consequently, cost escalations are far in excess of 25 per cent.
- Time schedules are not worked out accurately.

The time taken for processing feasibility reports depends upon the thoroughness of pre-investment studies and their scrutiny.

The data on inadequacies in estimates (see Box 1 and Table 4) make this clear. Generally, these are the consequences of inadequate investigation before preparing the feasibility report. Quotations may be available only for major items. Estimates are made for others based on the application of percentages. These are broken down into components such as due to change in price increase and change in scope.

There is also mismatching in projects involving linked investments in different sectors. Considerable time is lost in tying up the input and service requirements. The five year plans provide a framework for such linkage by specifying availability of investible resources and sectoral outlays and output targets. Yet feasibility reports cannot be tied up closely with five year plan schedules as necessary information of right accuracy is not available in advance. As a result, assumptions on inputs or demand are not realized either fully or on time. Consequently, project completion, cost, and viability are thrown out of gear.

Project Appraisal. The objective of appraisal is not
merely to accept or reject an investment proposal, but to recommend ways in which the project can be redesigned or reformulated to improve its technical, financial, commercial, and economic viability. While social cost benefit analysis is essential, the technical, financial, and commercial viability of a project also needs to be appraised. The main thrust of the appraisal by the Project Appraisal Division and the Bureau of Public Enterprises relates to a comparison of the situation with and without the proposed investment. However, rarely is a basket of proposals available as are alternative options, with details of costs and benefits for each, so that a choice can be made among competing alternatives. Projects in a sector are generally presented for approval one by one. Appraisal is limited to whether there are possibilities for minimizing the capital and operating costs, without redesigning the project benefits.

Appraisal would have to emphasize different factors for different sectors. Emphasis in one sector may be on the impact of low capacity utilization; in another, on escalation in capital costs or on fluctuations in operating cost. Analysis should be related to the factor chosen for emphasis.

Project Implementation Stage

Main scope of work during the project implementation stage includes:

- preparation of the detailed project report
- selection and finalization of contracts with process licensors
- selection of consultants for finalization of contracts
- preparation of expenditure profile/budget estimates
- finalization of project work contracts
- procurement of equipments and materials
- project construction—land acquisition, site preparation, scheduling, erection, and commissioning
- arrangements for start-up activities in consultation with operating departments
- management reporting for progress monitoring and control.

The bulk of the cost and time overrun occurs during the project implementation phase. A good analysis of the causes of the overrun is provided by

Multi-Level Scheduling. In large projects involving a large number of activities project schedules are prepared at multiple levels. Multi-level scheduling involves the preparation of a master project schedule, functional area schedules, and schedules for each of various work packages. Master project schedule is the schedule of major milestones. It is of interest to top management. Functional area schedules such as for construction, recruitment, or training are of interest to the heads of department of the functional areas concerned. Individual subcontractors involved in executing specific work packages are provided with work package wise schedules.

Along with activity schedules, it is necessary to prepare schedules for drawing control, material and equipment control, and construction control. A multi-level approach can be followed for these schedules as well.

CATS and RATS Scheduling. Another useful approach is to prepare two types of schedules, commonly known as CATS and RATS, at each level. CATS is Compressed Activity Time Schedule and RATS is Realistic Activity Time Schedule.

CATS is used for internal control of project while RATS is used for commitments with external funding agencies. The time difference between RATS and CATS provides an internal cushion for contingencies.

Multi-Project Scheduling. Multi-project scheduling is the task of preparing activity schedules for more than one project simultaneously under execution. Special attention has to be given to the scheduling of resources used by many projects. In addition to priorities for the activity within a project, priorities between projects also have to be taken into account in the allocation and transfer of resources among projects.

PERT/CPM. PERT (Programme Evaluation and Review Technique) and CPM (Critical Path Method) are the most widely used network techniques in project management. They focus primarily on time analysis. While CPM is associated with single activity times (deterministic times), PERT is associated with two or three activity times estimates (probabilistic activity times). CPM is more useful in repetitive projects such as construction projects and industrial projects involving repeated use of standard technologies (power projects, chemical and fertilizer projects, etc.). PERT is useful in non-repetitive projects such as R&D and industrial projects involving new technologies.
Both CPM and PERT require data bases on activity times.

**Resources Levelling, Allocation, and Time-Cost Trade-Off.** Project scheduling and execution depends on resources required by various activities and resources available for allocation. Three important questions connected with utilization of resources are:

- How should resources be allocated and activity schedules prepared such that resource utilization is as uniform as possible or follows a defined pattern?
- How should the resources be allocated amongst competing activities and competing projects (in the case of multi-project scheduling) so that projects are completed in minimum time within available resources?
- Where resource availability is not a major constraint, can project duration be compressed below its normal duration by compressing (or crashing) activity times? If so, how should activity durations be compressed with minimum application of additional resources? Stated the other way, when a trade-off exists between project time and cost, how should the time-cost trade-off be made?

Decision rules to deal with resource allocation problems are based on:

- activity time
- activity slack
- activity resource
- a combination of activity time, slack, and resources
- derived from application of mathematical programming methods.

A discussion of these can be found in Pant (1984) or Davis (1983).

**Line of Balance.** Line of Balance (LOB) is a project monitoring technique. It is a line drawn connecting the cumulative scheduled progress of various stages and the project as a whole, shown as bars on a chart. It enables simultaneous comparison of actual progress with scheduled progress for multiple stages of the project. The technique uses three charts:

- process chart (the project network drawn to a time scale)
- objectives chart (a chart which shows scheduled cumulative progress for the project and its various stages on a time scale)
- progress chart (with cumulative of scheduled and actual progress for various project stages).

The Line of Balance is drawn on the progress chart to show the profile of accomplishment vis-à-vis that scheduled.

Dikshit (1983). They may be grouped as follows along with those under project formulation:

- project formulation
- capabilities and availability of infrastructure
- system support inadequacy
- environmental constraints
- social, political, and behavioural aspects.

**Resource Planning and Utilization**

A detailed analysis of causes of time and cost overruns is presented in Table 2. Even though infrastructural availability and inadequate development of project-related capabilities continue to be formidable impediments to realization of time and cost objectives, system support inadequacy contributes to this in no small measure.

Such inadequacies reflect in the manner in which resources are allocated and utilized. The attainment of time and cost objectives depends directly on the allocation and utilization of resources (Davis, 1983). Moreover, internal project management systems have to be singularly concerned with the optimal utilization of scarce resources.

**Survey**

A survey was undertaken to understand the state of art on resource allocation and utilization in Indian projects. A questionnaire was administered to 45 project managers at senior levels from several large organizations in the public and private sectors. A brief summary of the practices based on their responses is presented below.

**Objectives.** The objectives considered most important were:

- minimization of project duration and delays
- minimization of costs
- maximization of present worth.

In practice, a mix of these was pursued.

Those who set the objectives included top management, project executives, and project planners. Sometimes, a joint committee from among these set the objectives.

**Activity Times.** Different practices were in use for estimating activity times. These included:
**Table 2: Causes of Cost and Time Overruns**

<table>
<thead>
<tr>
<th>Stage/Aspect</th>
<th>Causes</th>
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| Project Formulation Stage | * Lack of adequate coverage of costs pertaining to infrastructural facilities like utilities, storage tanks, approach roads, sidings, effluent disposal, office and township requirement, site preparation, loading and unloading facilities, etc.  
* Capital cost estimate not fully based on required basic engineering work, accurate assessment of foreign exchange requirement for import of material, equipment, and skills.  
* Time taken to line up foreign process licensors not considered. |
| Project Implementation Stage Capabilities and Infrastructure Availability (Infrastructure) | * Land acquisition — Action on land acquisition initiated after project clearance. Litigation leads to further delays.  
* Power — Severe power cuts in many areas affect power availability for fabrication and construction work. Moreover, there are frequency fluctuations, voltage dips, and power trips. This results in commissioning delays.  
* Transportation — There are severe limitations on wagon availability due to lack of adequate priorities for movement of project equipment and materials. Further, transportation of off-size equipment is difficult and disrupts time schedules.  
* Port limitation — Due to heavy congestion, long delays in unloading project materials.  
* Housing and facilities for project personnel — In most project sites, housing is a problem, particularly for contractor’s labour. Other facilities including medical, canteen, recreation, water, etc. not fully available. Hence, morale and performance of project personnel is affected. This also results in labour unrest, strikes, lockouts, etc. |
| Capabilities and Infrastructural Availability (Manufacturing, Engineering, and Technological) | There are serious constraints owing to inadequate development of:  
* Detailed engineering capabilities.  
* Equipment manufacturing capabilities — Owing to inadequate capacities, quality and reliability of equipment manufactured.  
* Construction capabilities — Owing to limited availability of experienced construction agencies, construction skills (like carpenters, masons, welders, etc.) and heavy constructions equipment.  
* Raw material supply capabilities — Owing to extremely constrained availability of critical project materials like steel of certain specifications and sections, cement, etc. Long-winding procedures for allocation of scarce materials lead to further delays.  
* Process technological capability — Required process technologies, except in respect of some commodities, are hardly available in the country. Selection of process licensors/consultants is a major source of delay. |
| System Support Inadequacy | * Project management systems are yet to be fully developed except in a handful of project organizations. This is a major bottleneck.  
* Tendering and Procurement — Procedures prescribed for tendering and procurement of project items are totally inadequate and result in increased risk of substandard work, schedule delays, and cost escalation.  
* There is close to no effort to develop human resources for professional project management competence. |
| Environmental Constraints | * There are inordinate delays in project clearance from the point of environmental impact assessment. Although this is important, there is a need to perform such assessments expeditiously in a way that does not impair the operational viability of the project itself. |
| Social, Political, and Behavioural Aspects | * A general lack of commitment and collective will to fulfil obligations.  
* Political interference and pressures of other social action groups. |
• single time estimates
• two time estimates
• three time estimates.

The single time estimate was the most commonly followed practice.

Although there are considerable variations in the methods used for estimating project activity times, in a majority of cases, the estimates are based on past experience. Other methods used included activity time analysis, use of performance norms, group discussions, industrial engineering studies, estimates supplied by foreign collaborators, estimates based on nature, quality, and complexity of work estimates supplied by consultants/contractors/suppliers, expert opinion from within the organization/outside consultants, and calculation on the basis of due dates and resource availability.

There was considerable variation in updating practices. They varied from computerized updating to manual updating. The frequency of updating also varied by project size and organization. The updating period for large projects was fortnightly, monthly, or six monthly. In updating, some replotted the entire network and established new critical activities. Some 'back set' the remaining activities while others crashed the following activities at a higher cost. At times only critical activities were monitored. Updating was through recourse to group discussions, review meetings, computer analysis, periodic progress reports, and feedback from monitoring agencies.

Resource Planning and Utilization. Not all respondents felt that resource availability was a constraint on the execution of projects, although the majority felt so. The methodologies to deal with the constraint varied. They included:

• use of priority rule usually based on criticality to take care of conflicts (e.g. minimum slack rules, shortest imminent operation first)
• subcontracting
• overtime/use of off-regular hours of work in case of resource conflicts
• allocation based on efficient utilization of resources
• fire fighting.

There does not appear to be sufficient clarity regarding the classification of resources used in projects as renewable, non-renewable, or doubly constrained.

Resource levelling to achieve desirable resource consumption profiles was not practised widely. Where it existed, activities were scheduled to ensure resource build up, such as that of the work force, in a desired manner. In organizations, levelling was attempted through inspection and trial and error.

Time-Cost Trade-Off. A majority of the respondents felt that some sort of time-cost trade-off was done, although they indicated no method for selecting the activities for crashing. Generally, only critical activities expected to get delayed were crashed. Use of overtime, extra shifts, increase in the number of contractors, and extra labourers was quite common to crash the activities. In some projects, senior executives decided on the allocation of extra resources while in others, the allocation was based on experience. Use of simulation and incentives to expedite activities was also mentioned.

Nearly 50 per cent of the respondents were certain while the rest either uncertain or somewhat, certain about the materialization of the projects as proposed and planned.

Multiproject Scheduling. Many respondents said that all projects were planned assuming their simultaneous execution. In some cases, planning was based on the availability of projects at different points in time. Quite a few had no knowledge about multiproject scheduling. Among those who faced the problem of allocation of scarce resources for multiple projects, past experience and some kind of priorities were evidently in use. The priority rules in use were of the following types:

• priority for projects with returns on a shorter period
• priority on the basis of criticality of the resource for project completion
• priority based on project due dates, degree of urgency, and importance to the organization
• priority based on cost and total investment in different projects to date
• priority based on persuasive power of different project managers.

Summing Up. The survey revealed that currently
there are hardly any formal project management systems in use that incorporate activity time estimation, resource levelling, time-cost trade-off, and allocation rules as a regular feature. Methodologies derived from extensive research have yet to find their application.

To obtain a better insight into this, senior project personnel in a few selected organizations were interviewed in depth with a survey questionnaire. The findings from this survey are described next.

Organizational Characteristics. Although specific capabilities in process knowhow, basic engineering, detailed engineering, and project management have developed to different degrees, turnkey contracting capability is presently very low. The situation varies widely across industries.

The presence on the international scene is very low. This may be because of lack of necessary expertise or experience, low investment capability, and technological obsolescence.

The major concerns of project managers were on time, cost, and quality, and not so much on the utilization of resources per se. This may be due primarily to the fact that the majority of respondents in the in-depth survey belonged to "promoter organizations" who executed projects for a parent organization in a captive mode.

Negotiated price and fixed contract fee were the dominant modes of payment. Projectized organization was the predominant organizational structure adopted. The matrix type of organization, which has some advantages for certain categories of projects, was not widely adopted. A majority of the organizations did not have job descriptions for project managers or project personnel. Providing incentives to project executives on successful project performance was not a common practice, although it was prevalent in some organizations in the private sector. Outright cash bonus, paid vacation, assignment of higher responsibilities, and commendations were some of the incentives used.

Cost Estimation. There was high reliance on previous experience in cost estimating. Risk analysis of cost estimates was not undertaken. In the public sector, the technical consultant was involved in cost estimation. In the private sector, a team consisting of the technical consultants, the future project coordinator, and the top management of project executing organization was involved in cost estimation. Project complexity by itself was not perceived as a major problem.

Manpower Loading. Usually a master manpower loading plan was prepared from the master project schedule. It was sometimes broken down into work package-wise plans. For actually building the manpower to peak requirements, there was an overwhelming reliance on contractors.

Material Planning. Two types of material requirement plans were in evidence: a master plan based on master project schedule and work package-wise material plans. Work package-wise material plans were more prevalent in the public sector, whereas the master plan based on material plans seems to be preferred by the private sector. Perhaps this is because of the more stringent accounting procedures and expenditure allocation requirements in the public sector. The procurement lead times of critical and high value items necessitated adjustment of project schedules forwards or backwards.

Choice of Suppliers/Subcontractors. The choice of suppliers/subcontractors was based on supplier performance record and was strictly based on an evaluation of tenders/quotations. Often the choice was limited. One of the problem areas identified was the coordination of multiple contractors.

Review. Periodic reviews of the master schedule and milestones were the main techniques for project monitoring. Use was not made of more powerful techniques such as S-curves, Line of Balance, and computer-based monitoring.

Delays. The overwhelming cause of delays in project execution was cited to be the material supply uncertainties arising out of technical deviations or unpredictable lead times. The next major cause was lack of effective coordination of the work of various agencies involved in project execution. Chasing suppliers was the major corrective action.

Conclusions. Our analysis has highlighted the major shortcomings that have resulted in time and cost overruns becoming a rule rather than the exception in project management. Yet, amidst the rather disappointing scene, there have been evidences of determined and successful project management. A careful analysis of successful projects shows the extremely vital role effective internal management plays in ensuring project success. We briefly consider below two such project
experiences—the Kudremukh iron ore project and the Adilabad project of the Cement Corporation of India—which are well known and documented.

**Kudremukh Iron Ore Project**

Kudremukh is one of the largest mining and beneficiation projects in the world. It was put up in a hilly location having heavy monsoon rainfall for about four months in the year, and strong wind pressures and foggy conditions for about nine months in the year. The project was implemented under a tight time schedule of 40 months for mechanical completion. It also achieved a significant saving in cost. Mirchandani (1983) provides a good account of the various project stages, problems involved, and corrective measures taken for the successful completion of the project.

Its successful implementation is ascribed to certain systematic approaches involving:

- clear formulation of goals
- identification of problem areas
- correct appreciation of environmental factors
- evaluation of flexible plan of action
- rigorous monitoring
- constant appraisal and follow up.

Time and cost overruns were controlled through measures such as:

- undertaking as many activities as possible in parallel
- simultaneous execution of design and construction phases
- procurement of equipment in as near an assembled state as possible
- standardization of motor capacity and modular design of electrical control.

Similar measures were taken in respect of several critical activities which included:

- association of Hindustan Steel Construction Ltd. (HSCL)/mining associate/engineer constructor from the early stage of the project
- introduction of bonus clauses in the contract with HSCL
- definition of intermediate milestones in contract clauses
- stockpiling of construction materials
- advance planning for steel and cement
- deployment of special purpose imported equipment for piling work and construction of silos
- left-in-place stuttering technique for concentrator and filtration buildings
- measures to stabilize unstable areas
- use of transit mixers
- speedy construction of the earthen dam, tunnel, slurry pipelines, and structural works
- involvement of manufacturer's representative at site during installation stage.

As a result of such efforts, despite the emergencies that were encountered, the Kudremukh iron ore project was completed on time within sanctioned costs, besides using Indian agencies as much as possible, maximizing indigenous content in equipment, and minimizing surplus manpower.

**Adilabad Cement Project**

The Adilabad project of the Cement Corporation of India (CCI) was the first of eight projects implemented concurrently to achieve a target of six million tonnes per annum by the year 1985-86. The Adilabad project of 1,200 tonnes per day of cement was taken up without any outside consultant. The project began in April 1979 and was completed within the scheduled period of three years and the original cost estimate of Rs 35.31 crore. CCI was able to cut the implementation time by nearly 50 per cent. What made this possible? The following factors have been identified in Adilabad's project organization approach:

- choice of a self-chasing type of organization
- a two-schedule approach using realistic and compressed activity times for project scheduling. The feasibility report, detailed project report, budgeting, and market plan were based on realistic activity time scheduling (RATS) while compressed activity time scheduling (CATS) was used in project implementation. The
time difference between the two schedules gave the cushion time for absorbing unforeseen delays

- use of special techniques for data base management, contract management, equipment categorization, project engineering, construction management, and progress monitoring. For instance, a 10-digit integrated data switching system was used comprising switching channels and switching keys. The switching channels represented the main areas and switching keys in each channel represented sections/disciplines/work flow/nature of work, etc.

- comprehensive tenders were issued complete with technical specifications, scope, and commercial conditions specifying phased deliveries based on master network. The payment system was tied to work progress

- use of VED (Vital, Essential, Desirable) technique for equipment categorization for phasing and sequencing order placement

- use of four-level planning and scheduling networks—Master Project Schedule (Level I), Area-wise schedules (Level II), schedules for execution of all activities under each programme, e.g. civil works, and mechanical erection (Level III), contract-wise schedules for control of site activities (Level IV).

Recommendations

Our analysis points to substantial benefits from successful project management. Better project management requires strengthening project management capabilities at all stages of the project life cycle (Korgaonker, 1983).

The pre-investment stage involving project identification, formulation, appraisal, and sanction is clearly the stage that provides the greatest scope for improvement.

Pre-Investment Investigative Work

More scientific pre-investment investigative studies need to be undertaken for large/complex projects. To achieve this, long-term association is necessary between public sector consultancy companies and research institutions. Pre-investment studies should focus on opportunities available, a global state of art review of trends, likely plant size, technologies, locations, environmental impacts, approximate value of investments involved, and process feasibilities. Such studies should be widely disseminated and discussed to generate creative project identification.

Project Preparation, Appraisal, and Investment

Capital cost estimation needs to be realistic. Special data bank/libraries need to be set up giving time and cost estimates for various activities in completed projects in major sectors. Cost estimates should take the likely impact of anticipated inflation and escalation clauses, likely revisions in administered prices and wage rates, and exchange rate fluctuations. The estimates should reflect total system costs including those in linked projects and development expenses for land acquisition, approach roads, water supply, and geological and geophysical investigations at site. For closely-held technologies, expenditure on purchase of information from abroad will have to be included. Risk analysis should be undertaken regularly to improve the forecast of estimated cost at completion (EAC).

A definite time schedule should be set up for the pre-investment stage of the project as, our analysis has shown, this stage is subject to inordinate delays. Agencies involved in issuing permits/clearance for foreign exchange, import licence, and custom clearance should be involved in appraisal to minimize the risk of delays in obtaining clearances. Scarce construction materials such as steel, cement, and petroleum, oil, and lubricants need to be planned along with the DPR to enable advance procurement action.

Organization Design for Effective Project Implementation

The choice of organizational structure should be in accordance with the nature of the project, its size, complexity, and type of process technologies involved (Kerzner, 1984). Centralized policy formulation with decentralized implementation appears best suited for large project management.

The organizational structure should provide for scheduling and monitoring, contract management, materials and equipment procurement, on-
site coordination and control, and information processing.

Adequate powers should be delegated to enable on-the-site decisions and thereby minimize avoidable delays. They should include powers to sanction extra items, deviations in contracts, etc.

The incentive/reward system for project personnel, particularly in remote, inaccessible, and backward areas, needs to be improved.

Consultants and their Appointment

A directory of Indian and foreign consultancy organizations needs to be developed with information on their field of specialization, projects handled, and past record.

Criteria have to be evolved for performance evaluation of design/consulting firms. They should include overall reliability and accuracy of cost estimates.

Implementation

Contract Management. A two-part bid system (one for technical and commercial terms and the other for price) should be preferred. Realistic escalation clauses need to be incorporated in the contracts. The contracts should contain effective bonus/penalty clause for rewarding completion of work ahead of schedule and stringent penalty for schedule slippage's. It will be advisable to consult vendors/contractors in framing specifications/inspection standards particularly where custom design and manufacture is involved.

Project Scheduling and Monitoring. Computer-based network analysis methods need to be used for project scheduling and monitoring. PERT/CPM techniques and their extensions should be adopted as a regular feature for time, cost, and resource allocation analysis. More use should be made of S-curves, LOB, and other techniques for monitoring and reviews (Choudhury, 1983).

Multi-level network systems should be adopted for integrated project scheduling and monitoring at various levels such as master project, functional, and work package levels. Such networks should be prepared for each major contracting firm. In drawing construction schedules, it would be preferable to involve contractors/vendors and detailed engineering consultants so as to ensure commitment. Project personnel should be deputed to major vendor's workshops to keep track of progress and follow up. It would be advisable to introduce a dual scheduling system for projects (on the lines of RATS and CATS). A project management information system should be introduced to enable effective project monitoring and control at various levels.

Construction. There is an urgent need to modernize and update construction technologies in India. Agencies with the capability are very few. New capacities for construction equipment should be created or imports allowed where necessary.

Research and Documentation. There is a need to research into appropriate project management models for large projects and on specific issues like effect of project uncertainties. Proper documentation of experience and data generated in project planning, execution, and commissioning phases, indicating the problems encountered, remedial actions taken, and lessons learnt, would be valuable.

Human Resource Development. Perhaps the most neglected area to date is the development of human resources for project management. There is no institution in the country offering a specialization programme in this field. Programmes are scarce even in construction management.

Efforts in post-experience training in project management are also limited. Specific courses in project management are not found in graduate or undergraduate curricula of universities and other institutions. Appropriate training and development measures are, therefore, a crying need of the hour to eventually man the projects with well-trained personnel.
### Table A: Time and Cost Overruns

<table>
<thead>
<tr>
<th>Time Overrun</th>
<th>No. of Projects</th>
<th>Cost Overrun</th>
<th>No. of Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>On schedule</td>
<td>5</td>
<td>No cost escalation</td>
<td>2</td>
</tr>
<tr>
<td>Up to 2 years</td>
<td>13</td>
<td>Up to 50%</td>
<td>9</td>
</tr>
<tr>
<td>2 to 3 years</td>
<td>10</td>
<td>50 - 100%</td>
<td>15</td>
</tr>
<tr>
<td>3 to 5 years</td>
<td>13</td>
<td>100 - 200%</td>
<td>17</td>
</tr>
<tr>
<td>More than 5 years</td>
<td>8</td>
<td>more than 200%</td>
<td>6</td>
</tr>
</tbody>
</table>

### Table B: Time and Cost Overruns on some Specific Projects (Rs. in crore)

<table>
<thead>
<tr>
<th>Name of Project</th>
<th>Cost Overrun</th>
<th>Time Overrun (Months)</th>
<th>Estimated Production Loss</th>
<th>Cost Overrun per Month</th>
<th>Production Loss per Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bukaro Steel</td>
<td>310.32</td>
<td>72</td>
<td>3016.75</td>
<td>4.31</td>
<td>41.92</td>
</tr>
<tr>
<td>Gujarat Refinery</td>
<td>27.99</td>
<td>12</td>
<td>436.00</td>
<td>2.33</td>
<td>36.50</td>
</tr>
<tr>
<td>Baira Hydel</td>
<td>71.71</td>
<td>50</td>
<td>151.80</td>
<td>1.20</td>
<td>2.53</td>
</tr>
<tr>
<td>Panipat Fertilizer</td>
<td>34.50</td>
<td>15</td>
<td>47.43</td>
<td>2.30</td>
<td>3.16</td>
</tr>
<tr>
<td>Obra Thermal Power</td>
<td>216.50</td>
<td>27</td>
<td>217.48</td>
<td>8.02</td>
<td>8.05</td>
</tr>
<tr>
<td>Baitadilla Iron</td>
<td>31.20</td>
<td>60</td>
<td>76.50</td>
<td>0.52</td>
<td>1.26</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>41</td>
<td></td>
<td>3.11</td>
<td>15.57</td>
</tr>
</tbody>
</table>

### Table C: Time and Cost Overruns in 15 Fertilizer Projects

<table>
<thead>
<tr>
<th>Location</th>
<th>Capacity (T/day)</th>
<th>Approval Date</th>
<th>Approval Budget (Rs Crore)</th>
<th>Completion Date</th>
<th>Completion Budget (Rs Crore)</th>
<th>Actual Time</th>
<th>Time Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barauni</td>
<td>Ammonia 600, Urea 900</td>
<td>Ammonia 12-67</td>
<td>Ammonia 35.1</td>
<td>Ammonia 11-71</td>
<td>Ammonia 91.6</td>
<td>Ammonia 1977</td>
<td>Ammonia 2.45</td>
</tr>
<tr>
<td>Bhutinda</td>
<td>900 1500</td>
<td>8-74</td>
<td>138.4</td>
<td>1-78</td>
<td>200.6</td>
<td>1976</td>
<td>1.36</td>
</tr>
<tr>
<td>Durgapur</td>
<td>600 900</td>
<td>2-66</td>
<td>28.5</td>
<td>1-71</td>
<td>26.8</td>
<td>1977</td>
<td>3.00</td>
</tr>
<tr>
<td>Gorkhnpur</td>
<td>200 300</td>
<td>19-72</td>
<td>11.8</td>
<td>7-45</td>
<td>18.4</td>
<td>1976</td>
<td>1.50</td>
</tr>
<tr>
<td>Haldia</td>
<td>600 500</td>
<td>11-71</td>
<td>88.9</td>
<td>10-76</td>
<td>243.4</td>
<td>1980</td>
<td>1.67</td>
</tr>
<tr>
<td>Korba</td>
<td>900 1500</td>
<td>6-74</td>
<td>127.3</td>
<td>9-77</td>
<td>22.1</td>
<td>See Table 4</td>
<td>2.30</td>
</tr>
<tr>
<td>Namrup expansion</td>
<td>600 1000</td>
<td>12-67</td>
<td>28.5</td>
<td>1-71</td>
<td>74.9</td>
<td>1976</td>
<td>1.16</td>
</tr>
<tr>
<td>Nangal expansion</td>
<td>900 1000</td>
<td>10-72</td>
<td>75.5</td>
<td>3-76</td>
<td>133.9</td>
<td>1978</td>
<td>1.38</td>
</tr>
<tr>
<td>Panipat</td>
<td>900 1500</td>
<td>2-75</td>
<td>139.7</td>
<td>5-78</td>
<td>187.6</td>
<td>1979</td>
<td>1.70</td>
</tr>
<tr>
<td>Ramagundam</td>
<td>900 1500</td>
<td>10-69</td>
<td>71.2</td>
<td>7-75</td>
<td>197.1</td>
<td>1979</td>
<td>1.70</td>
</tr>
<tr>
<td>Sindri modernization</td>
<td>900 900</td>
<td>1-73</td>
<td>88.9</td>
<td>2-78</td>
<td>167.2</td>
<td>1979</td>
<td>1.39</td>
</tr>
</tbody>
</table>

### Additional Notes

+ AS = plus Ammonium Sulphate  
* Triple phosphate  
** Nitrophosphate

Vol. 12, No. 4, October-December 1987
Table D: Major Events in the Implementation of the Korba Fertilizer Plant

1968
Feasibility report.

1969 October
Project approved.

1972 January
'Go ahead' given by Government. Estimate Rs 721 crore, including Rs 202 crore in foreign exchange. Target completion date June 1974.

1973 April
Foundation stone laid by the Prime Minister of India.

1973 September
Agreement with Technoexport for the air separation plant.

1974 January
Proposal cleared by the Public Investment Board.

1974 June
Project cleared by the Central Cabinet.

1974 November
Action on project slowed down. Revised cost estimate Rs 118.3 crore with completion date of December 1978.

1975 March
Allocation of funds for 1975 reduced to minimum required to meet earlier commitments. No fresh orders to be placed for equipment.

1975 September
First major Indian deliveries of electric motors.

1975 December
First shipment of air separation plant received.

1976
Efforts to cancel orders already placed.

1979 March
Total expenditure Rs 22.1 crore.

Table E: Causes of Time and Cost Overruns in Fertilizer Projects

<table>
<thead>
<tr>
<th>Projects</th>
<th>Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Badauni</td>
<td>Equipment failures</td>
</tr>
<tr>
<td>Bhatinda</td>
<td>Low estimates, scope changes</td>
</tr>
<tr>
<td>Durgapur</td>
<td>Equipment failures</td>
</tr>
<tr>
<td>Gorakhpur</td>
<td>Equipment deliveries, labour problems</td>
</tr>
<tr>
<td>Haldia</td>
<td>Floods, equipment deliveries</td>
</tr>
<tr>
<td>Korba</td>
<td>See Table 4</td>
</tr>
<tr>
<td>Namrup</td>
<td>Equipment failures</td>
</tr>
<tr>
<td>Nangal</td>
<td>Revisions, equipment deliveries, heavy rains, piling</td>
</tr>
<tr>
<td>Panipat</td>
<td>Low estimates, scope changes</td>
</tr>
<tr>
<td>Ramagundam</td>
<td>Approvals, equipment deliveries</td>
</tr>
<tr>
<td>Sindri modernization</td>
<td>Equipment deliveries</td>
</tr>
<tr>
<td>Sindri rationalization</td>
<td>Equipment failures, inferior pyrites</td>
</tr>
<tr>
<td>Talcher</td>
<td>Approvals, equipment deliveries</td>
</tr>
<tr>
<td>Trombay IV</td>
<td>Revisions to specifications</td>
</tr>
<tr>
<td>Trombay V</td>
<td>Engineering, Bombay Port congestion</td>
</tr>
</tbody>
</table>

Table F: Cost Overrun due to Inadequate Provision in Feasibility Report

<table>
<thead>
<tr>
<th>Project</th>
<th>Cost Overrun (Rs crore)</th>
<th>Inadequacy (Rs crore)</th>
<th>Inadequacy in Provision as per cent of Cost Overrun</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barauni</td>
<td>58.8</td>
<td>22.1</td>
<td>40</td>
</tr>
<tr>
<td>Haldia</td>
<td>155.4</td>
<td>37.8</td>
<td>24</td>
</tr>
<tr>
<td>Ramagundam</td>
<td>128.0</td>
<td>38.0</td>
<td>23</td>
</tr>
<tr>
<td>Sindri Rationalization</td>
<td>37.4</td>
<td>8.1</td>
<td>22</td>
</tr>
<tr>
<td>Nangal Expansion</td>
<td>58.3</td>
<td>13.9</td>
<td>23</td>
</tr>
<tr>
<td>Sindri Modernization</td>
<td>78.3</td>
<td>3.4</td>
<td>4</td>
</tr>
<tr>
<td>Trombay IV</td>
<td>32.3</td>
<td>4.6</td>
<td>14</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>544.2</strong></td>
<td><strong>117.9</strong></td>
<td><strong>21</strong></td>
</tr>
</tbody>
</table>

Table G: Cost of Delays in Projects — FICCI Study

<table>
<thead>
<tr>
<th>Project</th>
<th>Delay in Months (Rs crore/year)</th>
<th>Cost of Delay (Rs crore)</th>
<th>Final Increase in Cost of Projects (Rs crore)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominial Iron Ore</td>
<td>12</td>
<td>1.93</td>
<td>1.93</td>
</tr>
<tr>
<td>Bongaigaon Refinery</td>
<td>17</td>
<td>1.66</td>
<td>2.34</td>
</tr>
<tr>
<td>Rajven Cement</td>
<td>11</td>
<td>1.22</td>
<td>1.12</td>
</tr>
<tr>
<td>Acrylic fibre (IPCL)</td>
<td>28</td>
<td>6.12</td>
<td>14.28</td>
</tr>
<tr>
<td>CFFP Hardwar (BHEL)</td>
<td>21</td>
<td>6.72</td>
<td>11.76</td>
</tr>
<tr>
<td>High Pressure Boiler Plant (II)</td>
<td>36</td>
<td>1.92</td>
<td>5.76</td>
</tr>
<tr>
<td>Bokajan Cement</td>
<td>24</td>
<td>1.32</td>
<td>2.64</td>
</tr>
<tr>
<td>Basic Chemical Unit (HOCL)</td>
<td>100</td>
<td>0.72</td>
<td>6.00</td>
</tr>
</tbody>
</table>
References


