

PUBLIC WORKS DEPARTMENT

Government of Uttar Pradesh, India

UTTAR PRADESH STATE ROADS PROJECT Under IBRD Loan No. 4684-IN

Technical Assistance for Implementation of
Institutional Reforms in the Road Sector of Uttar Pradesh

SUGGESTION FOR IMPROVEMENT OF THE PWD COSTING METHODS, PROCESSES, CENTRALIZE COSTING/ESTIMATING POLICY FUNCTION, UPGRADE COST ESTIMATING TOOLS, SKILLS (FINAL)

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Glossary

ACWP	Actual Cost of Work the Performed	RMMS	Road Maintenance Management System
ADB	Asian Development Bank	SE	Superintending Engineer
AE	Assistant Engineer	SH	State Highway
BAC	Budget at Completion	SoR	Schedule of Rates
BCWP	Budgeted Cost of the Work Performed	SRF	State Road Fund
BCWS	Budgeted Cost of the Work Scheduled	SRP-II	State Road Project-II
BSR	Basic Schedule of Rates	SRSF	State Road Safety Fund
CE	Chief Engineer	SV	Schedule Variance
CRF	Central Road Fund	TA	Technical Assistance
CV	Cost Variance	TCE	Tata Consulting Engineers
DPR	Detailed Project Report	TCS	Tata Consultancy Services
EE	Executive Engineer	ToR	Terms of Reference
E-in-C	Engineer in Chief	UP	Uttar Pradesh
FMS	Financial Management System	UPPWD	Uttar Pradesh Public Works Department
FTC	Forecast to Complete	UPSBC	Uttar Pradesh State Bridge Construction Corporation
GO	Government Order	UPSRP	Uttar Pradesh State Road Project
GoUP	Government of Uttar Pradesh	UPSHA	Uttar Pradesh State Highway Authority
HDM-4	Highway Design and Management -4	VR	Village Roads
HQ	Head Quarter	WB	World Bank
IBRD	International Bank for Reconstruction and Development		
IDS	Institutional Development Strategy		
IDSP	Institutional Development and Strengthening Plan		
IRC	Indian Road Congress		
ISAP	Institutional Strengthening Action Plan		
JE	Junior Engineer		
MDR	Major District Roads		
MIS	Management Information System		
MoRTH	Ministry of Road Transport and Highways		
MOST	Ministry of Surface Transport		
MoSRTTH	Ministry of Shipping, Road Transport and Highways		
NABARD	National Bank of Agricultural and Rural Development		
NH	National Highway		
NHAI	National Highways Authority of India		
NPV	Net Present Value		
ODR	Other District Road		
PCC	Project Coordinating Consultant		
PMS	Pavement Management System		
PWD	Public Works Department		
RCC	Reinforced Cement Concrete		
RES	Rural Engineering Services		
RIDF	Rural Infrastructure Development Fund		

1. INTRODUCTION

1.1 GENERAL

A Policy Development and Institutional Development Study for the Public Works Department (PWD), Government of Uttar Pradesh was carried out 2000: the Final Report was published in June 2002.¹ As a result of this study some weaknesses and deficiencies in the costing system currently followed in PWD were identified, and certain recommendations made for improvement. The GoUP accepted these recommendations. In this context the GoUP targeted some definite action milestones as explained later in this report.

The intention of developing this report is to set out explicit directions, methodology, and practical guidelines for implementing the recommendations for improving the existing costing system of works in PWD as set out in the Study.

1.2 WEAKNESSES IN THE EXISTING COSTING SYSTEM IDENTIFIED BY TCE

The following weaknesses relating to the existing costing systems of UP PWD were identified

- (a) Proper costing system is not in place whereby comparison of cost effectiveness of in-house versus outsourced works may be done.
- (b) The unit costs are only relate to input materials, as output based cost parameters are not emphasized in the system.

1.3 RECOMMENDATIONS MADE IN THE INSTITUTIONAL DEVELOPMENT STUDY (IDS)

In order to overcome these deficiencies / weaknesses in respect of costing, the IDS Consultants made the following recommendations:

- (i) Build an effective management control around a cost centre approach for the Division. The cost centre approach implies budgetary control, standard costing, variance analysis for each centre at different levels in addition to functional streams like quality, maintenance, and development works.
- (ii) Follow the life cycle costing approach for the road developmental work, wherein, impact of road depreciation, ordinary maintenance and renewals are accounted for while costing for the asset. This approach will help in looking at the road in totality of its operating cycle and costs as per the life cycle.

¹ Policy Support and Institutional Development Study: TCE Consulting Engineers Ltd., TATA Consultancy Services, Sir Owen Williams Investment Lt, June 2002

- (iii) Maintain cost accounts, which can show:
 - (a) how resources are used,
 - (b) the purpose for which they are used and
 - (c) how well they serve the purpose.
- (iv) Provide requisite support to the maintenance management system through cost accounting. The cost accounting system can be used to determine if it is cheaper to execute the work in-house or under contract (out-sourced) by way of working out the comparison on contribution versus external purchase price.
- (v) With the objective of keeping the holding cost to a minimum, include inventory valuation in the costing system.
- (vi) The cost accounting system should support transfer pricing within the organization, especially for pooled road machines and equipment.

1.4 ACTION MILESTONES

The Government of Uttar Pradesh accepted the recommendations made in the IDS Report and targeted the following action milestones for implementation:

- a) Improve the PWD costing methods, processes, centralize costing / estimating policy functions , update cost estimating tools , skills etc.
- b) Implement IT based budgeting and costing system across PWD with appropriate controls and reporting functions.

1.5 WHY THE PWD NEEDS A COSTING SYSTEM

The PWD needs an excellent costing system so that it can prepare accurate and reliable cost estimates for its proposed projects. Without such a system it will not be possible to determine cost estimates that reflect the likely costs of the proposed projects. PWD budgetary requirements are currently based on these cost estimates. If the variance, differences, between their estimates and those quoted by Contractors are large then the PWD will be faced either with an over-spend (resulting in is a shortfall between the sanctioned budget and actual costs) or under-spend (where the sanctioned budget is greater than that actually required) situation. Neither of these situations are in the best interests of either the PWD or the GoUP.

1.6 THE METHODOLOGY ADOPTED IN WRITING THIS REPORT

Since the PWD requires an improved costing system the decision was made to include within this Report some of the basic concepts associated with costing systems and project costs. To that end Section 2 contains a list of terms used in management costing and gives some examples so as to enable the PWD to gain a greater understanding and appreciation of what is involved.

2. COSTING AND COST ESTIMATES

In the context of costing and cost estimating, many terms and phrases are often used. To avoid misunderstanding and confusion it was considered advisable to define those terms and phrases which are commonly used. In UP PWD some of the terms and phrases mentioned below may not be in common use.

2.1 DEFINITIONS

Estimate - A quantitative assessment of the likely outcome or result of a particular event. In the context of road management estimates are usually applied to project costs, resources, and durations. An estimate can be refined in terms of 'best, most likely, or worst' case scenarios based on previous statistics or knowledge. Standard deviations can be applied to estimates so as to avoid over optimistic outcomes.

Cost Estimate - A prediction of the likely cost, of an asset investment option, activity, or project. As a prediction, a cost estimate must address risks and uncertainties. Cost estimates are used primarily as inputs for budgeting purposes. They are determined based on experience (historical records) and economic forecasts. As such they are highly dependent upon the accuracy of previous records and the inter-action of 'the external environment' in terms of inflation, competition, and market forces.

Project Costing - This is the process of recording, tracking, and analysing all the various costs incurred during the execution of a highway project from inception to completion and handover, including defect liability period.

It is widely regarded as an extremely important component when evaluating and planning overall project strategies, since different strategies may well result in different project costs. Accurate project costing becomes critically important especially when there is a constant scarcity of funds, which is the normal situation with any Government organization such as the PWD.

In this case the costs of the individual elements that make up the project are summated. Basically these costs are for labour, plant and equipment, and materials. For work to be executed 'In-house' with the PWD's own labour force these individual costs will be, or should be, known. When external Contractors are engaged the PWD will only have access to the 'Selling' rates, i.e. the rate given by the Contractor when pricing the Bill of Quantities. This 'Selling' rate will include:

- (i) Labour costs associated with each item
- (ii) Plant and Equipment Costs associated with each item
- (iii) Materials costs associated with each item
- (iv) Spread of the Contractors preliminary items which are not listed in the Bill of Quantities. Such items, for example, may include:
 - a) provision of water, electricity, and telephones to the site
 - b) construction of haul roads
 - c) provision of Contractor's offices and equipment, store, canteen, mess room, etc

- d) access roads to the site office
- e) provision of weigh bridge to weigh materials brought to site
- f) provision of specific items of plant and equipment the costs of which may not be recoverable through the items given in the Bill of Quantities
- g) Insurance
- h) Costs of Contractor's staff and vehicles

The total costs of these items are normally spread over the items listed in the Bill of Quantities. As such they are additional to the elements of labour, plant and equipment, and materials. But will not be known by the Client.

- (v) Head office overheads - these are the costs borne by the Contractor for the running of his offices, and include the costs associated with preparing bids. Most Contractors, and Consulting firms, do not win all the projects for which they are bidding, but the costs of preparing such bids have to be recovered from the 'profit' made on those contracts which they do win.
- (vi) Profit - the objective of organisations operating in a competitive market is to make a profit out of which a contribution is paid to shareholders.

The problem of comparing 'In-House' costs with 'Out-sourced' costs is not a simple or direct one. Most Government organisations, such as the PWD, do not have to pay for the provision of their own offices, although in some cases they may have to budget for maintenance of same. Similarly Government organisations are not expected to make a profit. Hence their costs are very different from those of a private organisation, thus making cost comparisons very complex.

Life Cycle Costing - Total life cycle costing recognizes that the construction cost of a highway project is only part of its total cost. Construction costs are just the beginning of a series of costs to be borne by the owner (PWD), its downstream customers and users (stakeholders) until the end of its useful life.

Most people are aware that computers, for example, have a limited useful life of some three to five years. At the end of this time they will be obsolete and need to be replaced if they are to function effectively. In the same way a motor vehicle or piece of mechanical equipment has a limited life, even if it is maintained. To extend its life may not be acceptable solely on economic grounds.

A highway may be considered to have a life of some 20 years whilst a bridge may have a design life of some seventy years, or more. The life cycle of both roads and structures can be reduced by the application of wrong design standards and specifications, the poor quality of construction, increased traffic volumes, increased axle loads, and poor maintenance.

In the highway sector cost estimates normally include nothing more than total construction costs. However the more superior way is to consider life cycle costing, because this includes normal maintenance costs. Sadly budgets for new works and those for maintenance works are often funded separately, as is the case with the PWD who have Plan and Non-Plan budget headings. This can give rise to the expedient of building cheaply and ignoring the high future maintenance

costs, as was the practice in many countries, including the UK. But when life cycle costing is employed construction and maintenance costs are considered as a whole thus exposing the folly of the previous approach.

A typical example for the PWD is with respect to the proposed construction of a road on weak sub-soil. The alternative design solutions might be to build a rigid pavement or a flexible pavement. The costs of a rigid pavement are far greater than those for a flexible pavement but the maintenance costs are considerably less. Life cycle costing would enable the PWD to take into account both construction and maintenance costs and thus arrive at the most economic solution.

The economic life a road or structure can be extended by rehabilitation, but this process should be based on economics. It may be cost effective to strengthen a pavement or a structure so as to extend its life rather than adopt a policy of reconstruction. In the case of a road the expedient of adding a thick overlay or increasing the depth of the crust by the addition of a layer of crushed stone may be more economically viable than total re-construction.

Construction Contingency – A mark-up applied to cost estimates to account for uncertainties in quantities, unit costs, and minor risks. These would be contingency items considered by the Client.

In the case of a Contractor a typical example might relate to weather and flooding, when the Contractor may elect to increase certain rates if there was a chance that work may be interrupted by bad weather or flooding. A mark-up may also be applied by a Contractor in certain geographical areas where it is difficult to obtain local labour, or where Trade Unions are known to be particularly active and troublesome.

Engineers Estimate (PWD) also known as the Detailed Cost Estimate: This forms part of the technical approval process for a project. Based on this estimate the bidding process is initiated. The project should have an accurate, complete Engineer's Estimate, prior to technical approval and going to notice for inviting for bids (IFB). Revising an Engineer's Estimate during the IFB period should be the exception, not the rule.

Risk: The combination of the probability of an uncertain event and its consequences. A positive consequence presents an opportunity; a negative consequence poses a threat. In terms of the PWD, Performance Based Maintenance Contracts stems from a desire to spread the risk and for the Contractor to carry more of the risk than is the case with standard maintenance contracts.

Risks are present in most contracts dealt with by the PWD. In general the greater the preparatory work the less the risk. Changes in ground conditions for example are notorious for producing claims from the Contractor. The greater the degree of soil survey the less likelihood there will be of changes in, or 'unknown', ground conditions, thus reducing the probability of a justifiable claim from the Contractor.

Competent supervision on behalf of the PWD may be expensive, but it may well reduce the probability of works not constructed according to Specification. Works poorly executed will inevitably carry a higher risk of failure.

3. EXISTING SYSTEM OF COSTING IN UP PWD

A flow diagram showing the current procedures employed in the PWD for preparation and approval of cost estimates is given in Figure No.1.

The existing system of costing in UP PWD evolved during the pre-independence era. Since then hardly any major modification or revamping of the system has been attempted. The existing costing system employed in PWD is not compatible with the present day's mechanized and advance construction technology. Therefore revamping the costing system has become overdue. To improve the PWD's costing method, processes, and updating cost estimating tools and skills, a review of the costing system employed in the PWD was made. These review findings are presented below:

3.1 TYPES OF COST ESTIMATES

The following types of Cost estimates are generally prepared in the PWD:

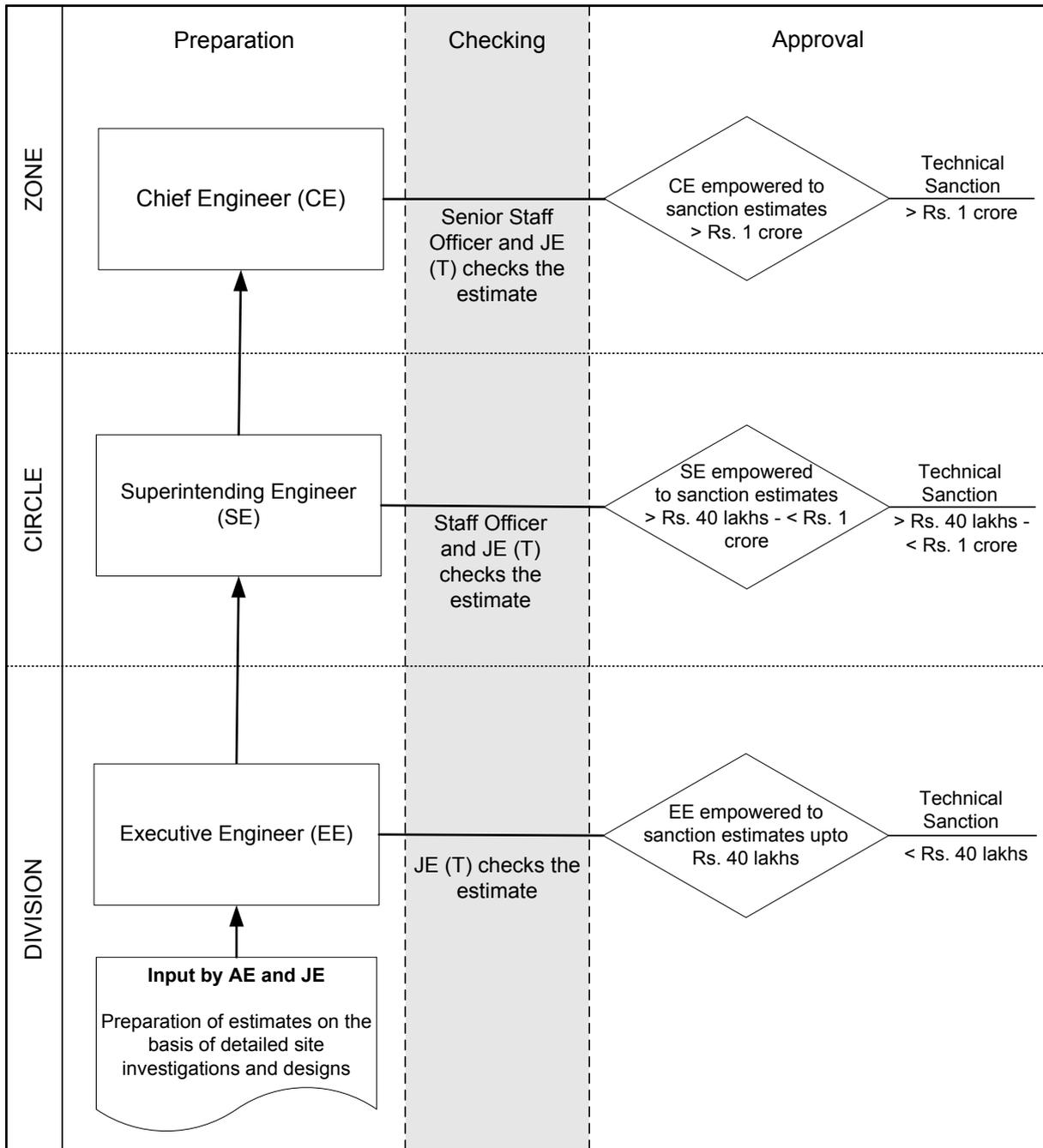
- Preliminary Estimates
- Detailed Estimates
- Revised Estimates
- Supplementary Estimates

Preliminary Estimate

The Preliminary Estimate (some times referred to as forecast estimate) is essential for judicious allocation of funds by the Government and any agency competent to issue the administrative approval of a project. This preliminary estimate is dependent upon the knowledge and experience of the Executive Engineer and his team. It is prepared in the Division under the direction of the Divisional (Executive) Engineer following the steps listed below.

- (1) The Divisional Engineer will prepare sample costs for the basic elements, such as earthworks, drainage, cross drainage, and road crust, based on the type of soil likely to be found in the area. These costs are 'unit costs' in that they are the cost per metre/kilometre, per square metre, per cubic metre, or simply number.
- (2) If it is a new road, the cost of land acquisition will also be included.
- (3) These costs are all based on historical data derived from similar completed projects, and the basic schedule of rates applicable for the Division.
- (4) The likely Specification and design standards are taken into consideration. Based on this information, and very approximate quantities, the Preliminary Estimate for the project is prepared.
- (5) An allowance for contingency and inflation is usually added to the above figures.

Figure No. 1 : Flow Diagram Showing Current PWD Procedures for Preparation and Approval of Cost Estimates



- (6) The preliminary estimate also includes a brief description, specification, design standards, availability of land, the relative importance of the work, and the scope of work/project to be executed. It covers not only the cost of construction but also contingencies and quality control charges.
- (7) In some exceptional cases, while preparing the preliminary estimates, some basic site investigations are carried out. But generally the preliminary estimates are prepared on the basis of personal knowledge of the concerned Executive Engineer and Assistant Engineer without taking into consideration actual site conditions. This can result in unrealistic estimates and allocation of funds, where cost overruns are the norm.

Detailed Estimate

The Detailed Estimate of work is prepared only when provision for the execution of the work has been voted by the State legislature on the basis of a properly sanctioned preliminary estimate.

The Detailed Estimate for a work is prepared for the purpose of gaining technical approval (sanction) of the project. It is one of the basic components of the detailed project report (DPR). In the PWD the Detailed Estimate is considered as a most vital element in the process of implementation of a project. Moreover, the Bill of Quantities, which forms a part of the bid documents, is invariably taken from the Detailed Estimate which has been technically approved by the competent authority in PWD.

Under the current system in the PWD the process of preparing the Detailed Project Report (DPR) commences soon after administrative approval of a project is received from the GoUP. The DPR is normally prepared by the Executive Engineer in the concerned Division.

The Detailed Cost Estimate is a component of the DPR. Generally the concerned Executive Engineer in whose jurisdiction the project is likely to be implemented, prepares the DPR and frames the estimate with the assistance of the Assistant Engineers and Junior Engineers. Mostly the preparation of the estimate is done manually as follows:

- (1) The first step in the process is to conduct detailed field investigations / surveys
- (2) The engineering designs and specification, based on data obtained from field investigations and surveys, are now finalised.
- (3) Details of the BoQ for the project works are determined on the basis of drawings, site measurements, and observations. The unit price of the BoQ item is taken from the standard applicable Basic Schedule of Rate (BSR) for the concerned Division. Over and above the cost estimate derived from the BoQ items a provision for contingencies and quality control is included in the final figure.

The BSR applicable for a specific Division is compiled by the Superintending Engineer of the concerned Circle. The BSR is a list of unit rates for various items related to road construction and maintenance. The unit rates themselves are derived from the Standard Data Book which gives the input component (work content) for each item in terms of labour (man days), materials (quantity), plant and equipment (per hour), small tools and plant (percentage of total cost), water (lump sum), contingency (percentage), and Contractor's profit (percentage).

The basic problem is that the items listed in the BSR relate to outdated technology, equipment, and materials. The rates themselves were derived when labour was prevalent with little in the way of plant and equipment. Thus they do not reflect current practices in terms of labour, plant and equipment, and materials.

The Detailed Estimate is approved by the Executive Engineer / Superintending Engineer / Chief Engineer according to their delegated financial powers. The competent authority to accord technical approval of the Works is directly related to the estimated value of the Works as follows:

- (1) The Executive Engineer (Division) can accord technical approval of Works up to an estimated cost of Rs.40.00 lacs.
- (2) The Superintending Engineer (Circle) can accord technical approval of Works with an estimated cost in excess of Rs.40.00 lacs but less than Rs. 100,000 lacs.
- (3) The Chief Engineer (Zone) enjoys the full powers to accord technical approval of works irrespective of their estimated cost.

According to rules laid down in the PWD manual the DPR should comprise of the technical report, design calculations, drawings, measurements, BoQ, and cost estimates.

Revised Estimate

A Revised Estimate is prepared if during the execution of the work a cost overrun is anticipated. If the anticipated cost is over a specified limit a Revised Estimate is prepared. The cost overrun may be on account of change in Specification, alteration in scope of work, or escalation in price of labour and materials. Preparation of the Revised Estimate is initiated by the Executive Engineer and is used for revising the administrative approval (sanction) of the work. In the Revised Estimate detailed reasons for cost overruns are specified for each item of work.

Supplementary Estimate

A Supplementary Estimate is prepared if, during execution of work, a cost overrun is anticipated on account of executing some essential extra items. These extra items may have been inadvertently omitted from the technically approved cost estimates, but without executing these extra items the work cannot be completed. With the approval of the Supplementary Estimate by the competent authority the excess expenditure incurred for completing the work is regularized and approved.

4. COMMENTS ON THE EXISTING SYSTEM

1. In UP PWD basic guidelines or manuals a consistent approach to the preparation of cost estimates, estimate reviews, estimate documentation, and management of estimate data are missing. Methods for preparing cost estimates have not been included in the existing Manual of Orders. Moreover, guidance on how to treat the common and recurring challenges encountered in the estimating process are not available to the Engineers responsible for framing the estimates.
2. The cost estimates are prepared in a traditional manner based on old practices; the Engineers are not familiar with modern advancements in costing systems and analysis.
3. Detailed engineering designs of a project are generally not based on detailed site investigations and testing. This adversely affects the quality of the DPR, upon which the costing of work is based, which ultimately leads to cost overruns.
4. The Basic Schedule of Rate and the Standard Data Book for Analysis of Rates on which the cost estimates are based is outdated. These documents are based on outdated construction technology involving labour based methods for the construction and maintenance of roads.
5. The detailed cost estimates of works only cover the construction costs. They do not take into account the life cycle cost of the project.
6. Preparation of the cost estimate is done manually. The use of computers and relevant software for preparation of the detailed cost estimate is generally not available in the PWD. Thus the current system is time consuming and labour intensive, resulting in the taking of short cuts.
7. An historical data base that can be used for costing, and which can provide assistance in the preparation of the preliminary cost estimates does not exist. This lack of preliminary information poses great difficulties when it come to preparing cost estimates during the conceptual phase of the project.
8. Risk management is not considered while preparing the cost estimates. Risks involved because of uncertainties as result of engineering solutions, socio-economic, and environmental issues, are not properly assessed and accounted for in the cost estimates.
9. A system for comparing the cost of the proposed new works with that of similar work already executed does not exist.
10. Analysing different design solutions during the scoping phase is rarely undertaken. Thus it is not possible to compare alternative solutions so that cost effective estimates can be developed.
11. The work relating to costing is highly skilled and requires specific knowledge. In the PWD the costing aspect of works is left to the Junior Engineers and Assistant Engineers who have little experience in costing aspects. Facilities and opportunities for providing training to the PWD personnel involved in costing processes for development of their skill is non-existent.

12. The cost estimate in the Division office is scrutinized on behalf of Executive Engineer by the Junior Engineer (Technical) attached to the Division. In order to make the review system more effective and meaningful, the review of cost estimate should be done by a more senior engineer, suitably trained in this aspect of work.
13. In practice the DPR consists of the estimate of work and a brief technical report containing the salient features of project. The poor quality of the DPR not only adversely affects the quality of work, but also results in time and cost overruns which lead to complications and disputes during contract administration. The IRC special publications of IRC SP-19 - 2001 has laid down explicit guidelines concerning the preparation of detailed project report but unfortunately they are never followed.

5. COMMENTS ON TCE RECOMMENDATIONS MADE BY TA CONSULTANT

5.1 EFFECTIVE MANAGEMENT CONTROL

The IDS Consultants recommended an effective management control approach for the Division incorporating budgetary controls, and standard costing, including variance analysis. This recommendation covers two basic issues, i.e. budgetary controls, and standard costing including variance analysis. Each issue and its implications are considered in the following Sections.

Budgetary Control

In the PWD the Executive Engineer in charge of a Division is primarily responsible for exercising budgetary control measures on the on-going works under his control. There is a proper system in place through which the Executive Engineer exercises the budgetary controls in that he is required to submit a monthly account of expenditure and revenue receipts to the Accountant General and to his superior officers. On an annual basis he is expected to review scheme wise expenditure against the budget allocation and the overall sanctioned cost of work. The budgetary control method presently in use in UP PWD is managed manually. The TA Consultant is in the process of preparing two separate Reports (Reports No. 16 and 28) on budgetary control measures, hence this issue has not been addressed here.

Standard Costing System

Standard costing is a technique which helps a manager to control costs and business operations. Standard costs are the predetermined costs of labour, plant and equipment, materials, and overheads for a selected period of time and for a prescribed set of working conditions. A standard cost is a planned cost for a unit of work. The technique of using standard costs for the purposes of cost control is known as standard costing. It is a system of cost accounting which is designed to estimate, or forecast, the cost of works based on predetermined, or standard, costs.

In the PWD the Basic Schedule of Rates should be considered as the standard cost for an Individual item used in the preparation of the cost estimate for a project. The actual cost can be ascertained only when a contract has been awarded and work completed. The estimated cost should be compared with the actual cost and the difference between them, or variance, determined. This should provide the basis for adjusting the standard costs, as given in the BSR, so as to improve future cost estimates.

Standard costing is a management control technique for every activity. It is not only useful for cost control purposes but is also helpful in production planning and policy formulation. It allows management by exception. In the light of various objectives of this system, some of the advantages are given below:

1. **Efficiency measurement:** The comparison of actual costs with standard costs enables management to evaluate the performance of various cost centers. In the absence of standard costing system, actual costs of different time periods may be compared to measure efficiency. Care has to be taken when comparing costs of different time period because circumstance of both time periods may be different. However a decision about a base time period (base costs used as standard costs) can be made with which actual performance (actual costs) can be compared.
2. **Finding of variance:** The performance variances are determined by comparing actual costs with standard costs. Management is able to determine where these differences are of concern and to take corrective measures at the earliest. A regular check on various expenditures is also ensured by standard cost system.
3. **Cost control:** Every costing system aims at cost control and cost reduction. The standard costs and actual costs must be constantly analyzed. In the first place standard costs need to be reviewed and updated in an effort to ensure that they accurately reflect current costs. Secondly the actual costs generated from each Works needs to be reviewed to ensure that where there is a difference the reasons for same are determined and corrective action taken.

The adoption of Standard Costing is not a cure for all costing problems within the PWD. It is a system which needs to be handled with care and PWD staff trained in its use and application. The basic cost information is that obtained from the most recently satisfactorily completed contracts. Under these circumstances the Works should be analysed and broken down into clearly defined and measurable elements.

One obvious element relates to drainage but for the system to be useful the drainage needs to be broken down into sub-elements. The whole approach lends itself to computerization and could be one of the first areas to be considered. Drainage for example could be broken down into the following sub-elements:

- a) Type
- b) Diameter
- c) Depth of invert below surface
- d) Type of material excavated to form trench:
 - (i) Rock
 - (ii) Sand / Gravel
 - (iii) Clay
 - (iv) Other

The above is not a complete list by a long way but has been included as a guide. Following analysis of the different types of drainage included in the Works it should be possible to determine the costs associated with each sub-element.

It goes without saying that the elements and sub-elements selected must be the ones which are included in most contracts.

Once the whole of the Works had been broken down into such elements it is necessary, as a check, to use the derived figures to determine the 'estimated cost' of the said Works. It is unlikely that the completed costs of the Works will be the same as the 'estimated cost'. Where the difference is large (over 5%) every effort must be made to determine the reason for the difference and to make the necessary adjustments.

These costs will eventually take the place of the basic schedule of rates. As more and more completed contracts are analysed so the accuracy of the cost estimates prepared using these rates will improve. The only additional requirement is to build an inflation factor into the system so that the standard costs are kept up to date.

Because circumstances change, and bidding is not a standard predictable science, it will be impossible for the cost estimates to match the bid prices, but they should be close enough for PWD purposes. Bidding theory has been developed in some countries so as to more accurately predict bid prices. The latter can be highly dependent upon the number of Contractors invited to bid. As the number increases so will the range of bid prices and there is always the danger that under these circumstances the Contractor who submits the lowest price may have made a mistake or else he is trying to 'buy' his way into the market.

In the PWD the preparation of standard costs can be improved by improving the quality of the Bill of Quantities because the BoQ is the basis for calculating the standard costs. Every effort should be made to prepare a standard Bill of Quantities in which the descriptions of the various items is constant from one project to another.

In some countries Cost Consultants have emerged with these types of skills. Some of the PWD staff need to be trained in this approach so that they too can carry out the analysis of bids to provide reliable cost data which can be used to prepare acceptable cost estimates.

Life cycle costing approach

One of the IDS consultant's recommendations was to adopt the life cycle costing approach in PWD. This aspect has been adequately addressed to subsequently in this report, but remains an issue which must be addressed by the PWD.

The only additional requirement is to build an inflation factor into the system so that the standard costs are kept up to date.

Support to Maintenance Management System through Cost Accounting

The IDS Consultant recommended that support to MMS was provided through cost accounting. This is an essential part of the data stored and used when it comes to prioritising maintenance works and establishing annual work programmes.

Whether HDM 4 is adopted, or otherwise, the PWD will need to develop a series of cost estimates for different types of maintenance intervention. These estimates will be used when it comes to preparing annual work programmes and budgets and much will depend upon the accuracy of the data stored in the program.

Once again a key task will be for those with the appropriate skills in costing to analyse a representative sample of recently completed projects to determine the latest maintenance cost figures. It will also be necessary to keep abreast of developments in material technology and plant and equipment as any changes could have a considerable impact on the maintenance cost data.

Maintenance of Cost Accounts:

The IDS Consultant emphasized the need to maintaining cost accounts since they can be used to indicate:

- (a) how resources are used
- (b) purpose for which used, and
- (c) how well they served the purpose.

One of the objectives behind writing Reports Nos. 16 and 28 was to enable the PWD to establish the means whereby they could determine expenditure against an associated budget. However only a really sophisticated accounting system will enable one to determine with any certainty the use to which the funds were put. But how well they served the purpose is not a function of an accounting system. That is a function of management. An accounting system will indicate budget and expenditures but only management can determine whether those funds were used wisely or not.

Reports Nos. 16 and 28 each contain a series of forms that have been developed as an aid to financial control. Where possible, existing budget heads have been used. Thus when annual budgets are prepared, say for each Zone, the Chief Engineer in that Zone will be able to see the various heads against which he can request a budget. This when the budget becomes sanctioned the Chief Engineer will know the full extent of each budget head. On a regular basis he will be able to record expenditure against each budget head showing the sum spent and the sum remaining to be spent. This should provide him with information on which he can make rational and well informed decisions.

For example these budgets heads are separated into Plan and Non-Plan Works for Roads and Structures. Under each separate budget head are listed the appropriate works and their sanctioned costs. These budget heads can be used to provide regular cost information in such a way that informed decisions can be taken.

In a similar way budget heads have been prepared for activities listed as Establishment. When these forms are used the Chief Engineer will be able to develop his own budget requests, and will know how much money has been sanctioned against each budget head. Training is a typical example of such a budget head. When the budget is under preparation the Chief Engineer will be able to determine how much money will be required for training during the next financial year.

Once the budget has been sanctioned the Chief Engineer will be able to compare the sanctioned budget against actual costs arising from implementation of the proposed training programmes.

It must be emphasised that in this work training must be given with respect to financial management. Any accounting system can only really perform when the staff have an understanding and appreciation of what the system can do and how it will help to more effectively manage their work.

Construction and Maintenance Costs

Report No. 16 considers the above costs from the perspective of Out-Sourced and In-House contracts. As that Report states the cost information and details arising from each type of contract is very different. Generally considerably more cost information will be available from In-House contracts. But, if the PWD was to modify their bid documents, some vital information would be provided by each bidder with respect to costs.

In many countries when submitting a bid the Contractor must also submit a programme linked to a cash flow forecast. Indeed it is not unusual for the contract documents to specifically state not only what is required in this respect but also the computer program which the Contractor must use. This approach has many advantages, especially as far as the Client, the PWD, is concerned.

In the case of long-term projects one of the objectives behind this approach is for the Contractor to show his cash flow forecast based on his project programme. As the project progresses the PWD can plot actual cash flows, payments made by them to the Contractor, and thus have a financial record of progress.

Inventory valuation

The inventory valuation is ideal where materials for execution of works are required to be supplied by the Department. Earlier a PWD Division, especially the maintenance Division, had to maintain a store for materials which are often required for maintenance works and for those materials which are stipulated in contract for issue to the Contractor. This system was prevalent when a permit was necessary to procure controlled materials, which included cement, steel, and bitumen. The inventory control system exists in PWD for the Divisional stores. Maximum stock limits are prescribed for each Division depending upon the workload of the Division and nature of work. Under the present system bitumen is procured by the PWD for road maintenance works. Since bitumen is a scarce commodity therefore soon after being placed in store it is issued on ongoing works, thus inventory value never exceeds the limit assigned to a division.

The Executive Engineer has to ensure that the inventory value is kept at a minimum. The inventory value is monitored regularly and the Executive Engineer is required to submit monthly stock returns. The inventory control process is mostly manual and does not require any improvement except computerization.

Transfer Pricing within PWD for Pooled Plant and Equipment

According to IDS consultant the cost accounting system should support transfer pricing within the organization especially for pooled plant and equipment.

Under the existing system plant and equipment can either be transferred from one PWD Division to another, or it can be hired out. This latter case includes hire to other PWD Divisions and hire to Contractors. It is understood that for In-House works plant and equipment is made available to the force account workers as and when required. At other times plant and equipment is hired to a Contractor because that was in the contract and at other times plant and equipment is hired to a Contractor simply in order to make some progress on the contract.

With respect to the latter case, no plant and equipment should be hired to a Contractor if he has proven documents claiming that he has the necessary plant and equipment required as part of the registration process. Under these conditions the contract should be terminated and a penalty imposed on the Contractor as well as removal from the register of approved Contractors.

When plant and equipment is transferred from one Division to another the transfer is generally based on value. How the value is derived is not known but a formal process of valuation and depreciation needs to be introduced. Thus the transfer would be based on 'book' or 'written down' value.

The way in which hire charges are determined is also not known but such charges must take into account maintenance and replacement costs. A computer system should be introduced into the Mechanical Division which not only maintains records of hire but also maintenance and repair costs. These records can be used to determine realistic hire charges, especially to Contractors.

6. SUGGESTIONS FOR IMPROVEMENTS

Based on the review and findings of the IDS Consultant, recommendations for improvement to the cost estimating process are given below. In the PWD the Cost Estimate is reckoned to be a basic document in respect to the costing of a project. Therefore if the preparation of the Cost Estimate is improved the entire costing system as it stands will also be improved. The suggestions given below have been prepared with this particular objective in mind.

6.1 MANUAL ON COST ESTIMATING

A comprehensive administrative manual on Cost Estimating for UP PWD should be developed. The purpose of such manual would be to provide a consistent approach to cost estimating, estimate review, estimate documentation, and management of the estimating data. At the same time it would provide guidance on how to treat the common and recurring challenges encountered in the estimating process. The scope and structure of the proposed manual is explained subsequently in this report.

6.2 FIELD INVESTIGATIONS AND TESTING

The Detailed Project Reports (DPR's) must include detailed engineering designs that have been preparing based on detailed field investigations and testing. This is an important aspect and even though it is mandatory it is often neglected. It is the duty of the authorities according technical sanction to ensure that all the field investigations and testing required for DPR have been faithfully carried out, and the engineering designs are based on the results of these investigations and tests. Any cost estimate and DPR which do not include these items should be rejected and action taken against the concerned PWD officers.

Budgetary provision for such surveys, investigations and testing should be allowed for in the preparation of annual budgets and earmarked separately in the administrative sanction of the work.

6.3 SYSTEM FOR QUALITY ASSURANCE OF COST ESTIMATES

From Quality Assurance considerations a system for the review of detailed engineering designs and cost estimates for major works and works of special nature should be developed. The Quality Assurance review may be carried out through some independent authority (outsourced or in-house).

6.4 MODIFY BASIC SCHEDULE OF RATES (BSR)

The scope of each item included in BSR should be consistent with the scope of activities included in the Specification. Even minor difference or deviation between an item in the BSR and scope of work described in the Specification may become a cause for dispute. The BSR must be modified so that it is consistent with the scope of the items described in MORT&H Specifications.

At the same time consideration should also be given to the elements which together make up a Project. These elements, and associated costs, will be used to determine cost estimates for future Projects. There should be a close relationship between the items in the Basic Schedule of Rates and these Elements.

6.5 MODIFY STANDARD DATA BOOK FOR ANALYSIS OF RATES

The rate analysis data book should be modified and upgraded. MOSRT&H have already published a standard data book which is compatible with the various clauses of MOSRT&H Specification. It is proposed that this is adopted, subject to review and revision, such that it is suitable for UP PWD works.

6.6 COMPUTERIZATION OF COST ESTIMATION

PWD should aim at computerizing the cost estimation process. Computerization would help in not only reducing the volume of paperwork but in reducing the time taken to prepare the cost estimate. Such a system would enable the ready comparison of costs of previously completed works on a Zone, Circle, or Division basis, and on a Project Type basis.

6.7 DEVELOP HISTORICAL DATABASE

As part of the computerisation process the PWD should develop a database of elemental costs of all completed projects based on the prevailing costs of plant and equipment, materials, and labour together with location and date. The data so generated would form the basis in preparing realistic preliminary estimates of future works and updating the Basic Schedule of Rates.

6.8 ANALYSIS OF ALTERNATIVE SOLUTIONS

The PWD should introduce a system whereby alternative solutions are prepared during preparation of the Detailed Project Report. These alternative solutions can be analysed during the scoping phase to obtain a preferred alternative for developing a cost effective estimate, including life cycle costing. The Detailed Project Report should discuss at length the various alternatives solutions considered and why the preferred option, and associated life cycle costs, was adopted for the project under preparation.

6.9 LIFE CYCLE COST

Life cycle costing of projects is not in place in the UP PWD. All major projects should be considered on the basis of life cycle costs which should be prepared as part of the Cost Estimate. This system will help in adopting a cost effective approach in which construction costs and forecasted maintenance costs are considered together. It would overcome the desire for cheap construction, based on poor design standards and Specification, which inevitably leads to higher maintenance costs throughout the life of the Project.

6.10 REVIEW OF COST ESTIMATES

An effective system for reviewing cost estimates should be developed that embraces the Division, Circle and Zone. Dedicated staff, suitably qualified and trained, should be deployed at all levels to review the cost estimates prior to according technical sanction.

6.11 TRAINING

Junior Engineers and Assistant Engineers are the backbone in the process of preparing the cost estimates. These personnel should be given training in the use and application of the computerised costing system and quantity surveying.

They must also be given additional training in the preparation of design alternatives, which should be discussed and approved by the Executive Engineer before undertaking the more detailed design.

In addition these Engineers should be given training as regards the preparation of Detailed Project Reports so that they fully understand the implications of the work they undertake.

7. PROPOSED PROCESS FOR IMPROVING THE PWD COSTING SYSTEM

7.1 DEVELOP A COST ESTIMATING MANUAL

The first step for improving the costing system in UP PWD is to develop a comprehensive administrative manual on Cost Estimating for UP PWD. This would provide the necessary guidelines and directions to the UP PWD Engineers in the cost estimating process.

A Committee of some four to six Senior PWD Officers should be formed to oversee the Unit responsible for the development of the Cost Estimating Manual. The Unit itself would comprise of some four or five members drawn from the working Circles and Divisions and headed by a Superintending Engineer. Members of the Committee and the Unit should be chosen on the basis of their proven capability in accomplishing such tasks.

Prior to starting work on this Manual the Unit should be suitably trained and an External Consultant (probably a Cost Consultant) appointed to provide leadership and guidance. One of the tasks facing the Committee will be the development of Terms of Reference for the Unit and for the External Consultant.

A secondary consideration would be that of computerisation. The development of a Manual for Cost Estimating should ideally include the computerisation of the cost estimating system and processes, including the establishment of a database.

However before the Manual can be prepared the following steps and decisions need to be taken and approved by the Committee:

1. The drawings, Bill of Quantities and the Specification must all be in agreement: areas of conflict will need to be highlighted and proposals for resolution of any conflict prepared, discussed, and action taken. These three documents should be 'mutually explanatory'.
2. Cost elements need to be determined that are relevant to the projects undertaken by the PWD. These cost elements must be linked to the Bill of Quantities and Specification. As a result of the decision to establish cost elements the Basic Schedule of Rates will become obsolete.
3. The costing system for In-House works (see Report No. 16²) is based on Cost Centres which in fact are the same as Cost Elements.

Ideally the framework and structure of the manual should cover the broad issues listed below:

² Report No 16: Review Report on implementation of IT-based budgeting and costing systems across PWD with appropriate controls and reporting functions

Cost Estimating Guidelines and Procedures for UP PWD

Part One: Administration

- a) Purpose and basic objectives
- b) Definitions and Explanation of Cost Elements
- c) The Cost Estimating Process and application of Cost Elements
- d) Systems and Procedures for the preparation of Cost Estimates
- e) Roles and Responsibilities
- f) Zone Review
- g) Quality Assurance procedures
- h) Cost Estimating Methodology
- i) Cost Estimating and Project Development Level

Part Two: Cost Elements and Associated Costs

- a) Cost Elements: their determination, use, and application
- b) Cost Estimating Database and range of data held
- c) Elemental Costs determined from previously completed projects
- d) Land acquisition
- e) Right of Way
- f) Environmental and Social Safeguards Factors
- g) Cost and Time indices: all costs must be brought to a common base date

Part Three: External Factors Which Can Influence Costs

- a) Risk and Contingency items
- b) Geographical location
- c) Difficult working site, constraints, etc
- d) Soil conditions
- e) Availability of local materials
- f) Specialist / unusual type of work included in project requiring specific expertise or plant and equipment
- g) Competition amongst Bidders / Contractors, and Contractor availability in the region
- h) Value and complexity of the project
- i) External Economic Factors: inflation,
- j) Timing and placement of advertisements inviting Bids
- h) Determine Estimate basis

Part Four: The Basic Process

- a) Preparation of base estimates
- b) Check list for base Estimate
- c) Determine Risks and Set Contingency
- d) Design: various feasible solutions considered
- e) Preliminary Engineering Costs
- f) Planning
- g) Scoping
- h) Plan, Specification and Estimate (PS&E) / Engineer's Estimate or Detailed Estimate
- i) Important Factors
 - (i) Scheduling/Lead Time
 - (ii) Estimating Lump Sum Items
 - (iii) Force Account
 - (iv) Specialty Work
 - (v) First Time Used (Item included first time in estimate on which the bidders have no information)
 - (vi) Utilities
 - (vii) Permit Conditions
 - (viii) Independent Estimate/Estimate Review
 - (ix) Resources

Training

Once the Cost Estimating Manual has been prepared the PWD staff will need to be trained in its use. Prior to this a detailed training programme will need to be prepared so that the training is focused and covers the issues that staff are likely to meet.

As and when problems arise PWD staff will need to know as to who in the PWD is capable of providing competent advice and help to resolve these specific problems.

7.2 DATA COLLECTION AND FIELD INVESTIGATIONS

Indian Roads Congress SP-19 -2001 has laid down detailed guidelines for surveying, site investigations, and data collection for the preparation of detailed project report for Highways. These guidelines must be rigorously followed for all projects of value exceeding Rs.25.00 lacs.

7.3 QUALITY ASSURANCE OF COST ESTIMATES

The Quality Assurance check with respect to design and costs should be applicable for all major projects of value more than Rs.10.00 crores. There should be an In-house Agency for conducting Quality Assurance check for works costing between Rs.10 crores to 20 crores. The Quality Assurance check for works exceeding Rs.20.00 crores in value should be carried out through an Out-sourced Agency similar to that in place for bridges. This aspect should be clearly mentioned in the Cost estimate guidelines.

7.4 BASIC RATES

Basic rates for Labour, Plant and Equipment, and Materials should be established for each Zone. The structure of the Basic Rates should be standardized for the entire State; however, it is anticipated that these rates may vary from Zone to Zone, and within each Zone. Hire charges for plant and equipment should be determined on the basis of method recommended by MOSR&TH. Wages for labour shall be governed by the minimum wages fixed by the GoUP from time to time. The cost component of materials should be decided based on the market survey. These figures must be updated regularly and frequently to ensure that they reflect current market prices.

For accomplishing this task a committee of some five or six Senior Engineers drawn from the working Zones should be formed and a specific time frame should be assigned for completing the task.

7.5 COMPUTERIZATION OF COST ESTIMATION PROCESS

Computerisation of the Cost Estimation process and associated database is essential. The PWD will need to consider estimating software programs available. They will need to decide whether to purchase an off the shelf program, preferable, or to have one custom made.

Whilst a computerized process involves the purchase of hardware and software, plus training for PWD staff, significant savings in time and accuracy are anticipated. In particular, cost estimates can be prepared more rapidly and with less effort than previously since it is easy to modify existing cost estimates in accordance with current information.

For the development of a computerised costing system in UP PWD the PWD is strongly advised to employ the services of a firm of Cost Consultants who are experienced not only in the preparation of cost estimates but are also experienced in the application of IT in this area.

Some of the common features of computer aided cost estimation software include:

- Databases for unit cost items such as labour wage rates, equipment rental and material prices. These databases can be used for any cost estimate required. If these rates change, cost estimates can be rapidly re-computed after the databases have been updated.
- Databases can be established for specific components, plant and equipment, materials and construction processes.

- Import utilities from computer aided design software for automatic quantity-take-off of components. Alternatively, special user interfaces may exist to enter geometric descriptions of components to allow automatic quantity-take-off and generation
- Allows simulation of different construction processes or design changes for the purpose of tracking changes in expected costs.
- Provisions for manual review, over-ride and editing of any cost element resulting from the cost estimation system
- Flexible reporting formats, including provisions for electronic reporting rather than simply printing cost estimates on paper.
- Archives of past projects to allow rapid cost-estimate updating or modification for similar designs.

A typical process for developing a cost estimate using one of these systems would include:

1. If a similar design has already been estimated or exists in the PWD archive, the old project information is retrieved.
2. The Cost Engineer can modify, add or delete components in the project information set. If a similar project exists, many of the components may have few or no updates, thereby saving time.
3. A cost estimate is calculated using the unit cost / elemental cost figures and checked to ensure that there are no errors.

7.6 SKILLS

For effective and efficient implementation and operation of computerized cost estimating process the estimators at different levels should be well versed in the under mentioned skills:

- Computer Proficiency
- Excellent skills in using all software procured for cost estimating
- Excellent skills with computer programmes related to MS office, Microsoft Project or any similar project management software – a complicated and sophisticated programme is not required.
- Knowledge of resource scheduling and 'S' curves
- As well as computer skills the estimator should have adequate exposure in construction process at site, procurement of works, and contract administration.

7.7 DEVELOP HISTORICAL DATABASE

The computerized historical database for costing should be maintained at all levels i.e Division, Circle and Zone. The database should include completed works only. On-going works should not be included since they may be subject to Variation Orders and claims, all of which must be taken into account when determining the elemental costs. The historical database should cover the following;

- i. Labour wages
- ii. Market rate of materials,
- iii. Hire charges for plant and equipment,
- iv. Fuel charges
- v. Average cost per kilometre of road works, construction and maintenance depending upon type, Lane configuration wise and specification wise.

7.8 ANALYSIS OF ALTERNATIVE SOLUTIONS

The detailed project report should consider the various alternative solutions (for works costing more than Rs. 1.00 crores). It should clearly state why the preferred solution was adopted for the project under preparation. To ensure compliance with this requirement a check list for the review of estimates should be introduced. This aspect should also be included in the proposed guidelines for cost estimating.

7.9 LIFE CYCLE COST

For major projects, exceeding say a value of Rs. 5.00 crores, estimation of the total life cycle cost based on the design life should be made mandatory.

To analyse the life cycle cost of a proposed road or structure it is necessary to estimate the maintenance costs once construction has been completed. The stream of maintenance costs over the life of a road or structure depends upon subsequent maintenance policies and use, in particular traffic volumes and axle loads. The nature and frequency of maintenance works will be reduced if the road or structure undergoes periodic maintenance when required, based on condition surveys, and any rehabilitation or upgrading work.

Since the trade-off between capital cost and maintenance costs is an essential part of the economic evaluation, Maintenance costs must be viewed not as a separate entity, but as a part of the larger parcel of life cycle cost at the planning and design stage. The techniques of estimating life cycle costs are similar to those used for estimating capital costs, including empirical cost functions and the estimating of labour, material, and plant and equipment costs. However, it is the interaction between capital costs and resulting maintenance costs which deserve special attention and which is the basis of the life cycle costing approach.

The value of the cost exponent may influence the decision whether extra capacity should be built to accommodate future growth. A simple rule of thumb would suggest that this is not a good strategy to adopt. Do not build in future expansion until the time is right. Better to increase capacity as and when required, but not before. Of course it is necessary to build into the cost estimate land acquisition which must allow for any future expansion. Similarly, the economy of scale may also influence the decision on rehabilitation at a given time. As the volume of rehabilitation work increases it can become a capital project in its own right with all the implications of its own life cycle. Hence, the cost estimation of a rehabilitation project may also involve capital and maintenance costs.

The stream of maintenance costs over time represents a series of costs at different time periods which have different values with respect to the present. Consequently, the cost data at different time periods must be converted to a common base line using, NPV, if meaningful comparison is desired.

7.10 SYSTEM FOR THE REVIEW OF COST ESTIMATES

A system for review of cost estimate exists in PWD at the level of Division, Circle and Zone level, but in practice it is cursory in nature. To make the review process more effective, a dedicated Technical Cell, exclusively for review of cost estimates and dealing with all matters related to costing, should be created at Zone, Circle, and Division level.

The following composition of dedicated teams is proposed at the various levels:

- Zone: Superintending Engineer (Costing) supported by Assistant Engineer (Costing)
- Circle: Executive Engineer (Cost Estimates) supported by Assistant Engineer (Costing)
- Division: Assistant Engineer (Cost Estimation) supported by Junior Engineer (Costing)

The responsibilities and line of communications for the staff of cost estimate cell would be clearly defined in the guidelines for cost estimation.

7.11 TRAINING

It is imperative that the PWD train all its staff involved in the costing process based on the Manual. The training component should specifically address cost estimate preparation, which may be composed of:

- Introduction to Cost Estimating
- Contract and Estimate Preparation
- Risk Management
- Life cycle cost estimate.
- Computer aided cost estimating

A Class room and workshop system of training should be followed and all those attending the training courses tested to ensure that they have gained the required understanding of the costing process,

7.12 CASH FLOW FORECASTING

As previously mentioned the PWD is strongly advised to insist that for major projects the Contractor must produce a programme clearly indicating how he plans to undertake the work. Although he may have used the technique of critical path networks the programme submitted must be in bar chart format since it is so much easier to read and understand. The PWD may elect to insist that such programmes are prepared by the Contractor using a specific software

program, such as MicroSoft Project. As well as submitting a programme the Contractor must also provide a soft copy of same.

In addition to providing the programme the Contractor must also submit an 'S' curve or cash flow forecast and a table listing the anticipated value of work completed each month. For major projects, with a duration of 12 months or more, the PWD is advised to determine the Net Present Value (NPV) of each bid and, all other things being taken into consideration, award the project to the Contractor with the lowest NPV.

This technique has the simple but excellent property of penalising those Contractors who have elected to front load their bids. This is the process in which a Contractor will inflate the rates of items which are timed towards the start of the project and to deflate those that are timed towards the end of the project. In simple monetary terms the final value of this type of approach may be less than that of a Contractor who has not used this method. When the time value of money is taken into account the Contractor who has front loaded his bid will end up with a higher price and will therefore lose out. In many countries the practise of front loading is illegal and sufficient reason for rejecting a bid. But adopting the NPV approach provides the Client with the reason.

This approach is highlighted in the simple example given in Table No. 1. The monthly cash flows provided by Contractor A, B, and C is given together with the NPV Factor which is the discount rate based on a monthly interest rate of 1%. The NPV shown for each Contractor is the cash flow for a given month multiplied by the appropriate NPV Factor. Under normal circumstances the contract would have been awarded to Contractor B who had quoted the lowest bid price. Contractor C was second lowest and Contractor A was third lowest. When the time value of money is taken into account, as shown by the NPV Factor, Contractor B no longer has the lowest bid price: Contractor A now has the lowest bid price.

Table No. 1 : Monthly Cash Flows Taking Time Value of Money into Account

Month	NPV Factor	Contractor A		Contractor B		Contractor C	
		Value	NPV	Value	NPV	Value	NPV
	0.99010	1,000,000	990,099	3,800,000	3,762,376	2,400,000	2,376,238
2	0.98030	1,200,000	1,176,355	3,600,000	3,529,066	2,400,000	2,352,711
3	0.97059	1,400,000	1,358,826	3,400,000	3,300,007	2,400,000	2,329,416
4	0.96098	1,600,000	1,537,569	3,200,000	3,075,137	2,400,000	2,306,353
5	0.95147	1,800,000	1,712,638	3,000,000	2,854,397	2,400,000	2,283,518
6	0.94205	2,000,000	1,884,090	2,800,000	2,637,727	2,400,000	2,260,909
7	0.93272	2,200,000	2,051,980	2,600,000	2,425,067	2,400,000	2,238,523
8	0.92348	2,400,000	2,216,360	2,400,000	2,216,360	2,000,000	1,846,966
9	0.91434	2,600,000	2,377,284	2,200,000	2,011,548	2,400,000	2,194,416
10	0.90529	2,800,000	2,534,803	2,000,000	1,810,574	2,400,000	2,172,689
11	0.89632	3,000,000	2,688,971	1,800,000	1,613,383	2,400,000	2,151,177
12	0.88745	3,200,000	2,839,838	1,600,000	1,419,919	2,400,000	2,129,878
13	0.87866	3,400,000	2,987,453	1,400,000	1,230,128	2,400,000	2,108,790
14	0.86996	3,600,000	3,131,867	1,200,000	1,043,956	2,400,000	2,087,911
15	0.86135	3,800,000	3,273,128	100,000	86,135	2,400,000	2,067,239
TOTAL NPV		36,000,000	32,761,260	35,100,000	33,015,777	35,600,000	32,906,733

It is obvious that Contractor B 'front loaded' his bid and loses out to Contractor A when the time value of money is taken into account

During the project implementation stage the PWD should monitor the Contractor's financial progress against his original 'S' curve. This will provide all the required evidence for any action considered necessary.

8. ACTION PLAN FOR IMPLEMENTATION

In order to implement improvement in costing system in UP PWD following action plan is recommended.

A. Development of Manual on costing

- PWD to constitute a Committee for developing Manual on Cost Estimating:
- The PWD Committee, with the assistance from the TA Consultant, to prepare draft terms of reference for the Out-sourced Cost Consultant, one of whose tasks will be to prepare the Manual
- PWD to appoint the Cost Consultant and PWD staff to work with Cost Consultant as a team. This team must participate in the process since understanding and ownership of the Manual are vital requirements if the Manual and system is to have any chance of success.
- Prepare Draft Manual, discuss with PWD Committee, modify / revise as appropriate and submit to GoUP for approval
- Obtain Government approval on the draft of Manual
- Conduct workshops at Zone HQ to train the field staff in use of the Manual
- Issue GO for implementing the Manual

B. Development of Detailed Guidelines for Preparation of DPR

- PWD to constitute a Committee overseeing the development of detailed guidelines for carrying out field investigations and preparation of DPR. The same Committee as above would be appropriate. Committee to prepare suitable terms of reference for Cost Consultant and his PWD team.
- Cost Consultant to formulate guidelines and submit to Committee for approval
- Obtain GoUP approval on Guidelines
- Issue GO for implementing the guidelines

C. Establishment of Cost Elements and Historical Cost Records

- PWD to constitute a Committee to prepare suitable terms of reference for Cost Consultant and his PWD team. This would include the establishment of cost elements and historical costs as well as a computerised system.
- PWD to appoint the Cost Consultant and PWD staff to work with Cost Consultant as a team. This team must participate in the process since understanding and ownership of the cost elements, their use and application within the PWD are vital requirements if the system is to have any chance of success.

- Prepare detailed list of proposed Cost Elements, together with their historical costs, discuss with PWD Committee, and demonstrate to their satisfaction that the system can be used to increase the effectiveness and efficiency of the current PWD system. Modify or revise the system as appropriate.
- Computerise the above process and system: the Cost Consultant to be responsible for this work. This should take place within one Division, which will act as a pilot.
- Under the guidance of the Cost Consultant prepare historical records based on previously completed projects.
- Build into the computer program the means to update all historical records using a methodology that is viable, approved, and easy to replicate.
- At each stage, and at the very least monthly, report to the Committee and explain the progress made. If possible a demonstration should be given so that the Committee members can see the actual progress made.
- At suitable points the data held on the database should be used to determine the estimated cost of a some four or five recently awarded bids the financial details of which must not be disclosed to the Cost Consultant and his team. This will clearly demonstrate any areas of weakness which must be addressed, and also the progress made. The objective is to build PWD confidence into the system so that they will use it in the future.
- Upon completion the whole system and process must be tried and tested in the Division before being implemented in the Circle. Following successful implementation in the Circle the system can be introduced into the entire Zone.
- The implementation process must be handled with great care so as not to over-stretch the Cost Consultant's and the PWD's resources. The implementation process must be developed by the Committee and the Cost Consultant.
- Once the system has been proven in operation it must be approved by the GoUP.
- The use of Cost Elements and the historical cost database must be enforced by GO.

D. Create a Dedicated Cell for Review of Cost Estimates in Zone, Circle and Division

- Zone: SE (Costing) -1, AE (Costing) -2
- Circle: EE (Costing) -1, AE (Costing) -1
- Division: AE (Costing), JE (Costing)

E. Strengthen the Quality Management Cell in Application of Quality Assurance Measures

The Quality Management Cell must strengthen the way in which the design and costing aspects of projects are quality assured.

F. Train PWD Field Staff in Cost Estimation

If the Cost Estimating system, based on the new Manual, is to function smoothly and well the PWD staff must be trained in its use and application. This training must be tested to ensure that the required level of understanding has been attained by those who attend the training programmes.

9. MEETING HELD WITH FOCUS GROUP F

The meeting with Focus Group F took place on 3rd July 2008 when the Report was discussed and finalised. But the Chief Engineer, and Chairman of the Focus Group, requested that a comment be added to the Report as follows:

"A four or five page note covering the issues raised in this document should be sent to all field officers.

Training is vital if the estimating process is going to be improved. Specific training in the preparation of estimates should be given in the following road related areas:

1. New road construction
2. Widening of existing roads
3. Re-construction
4. Rehabilitation
5. Strengthening
6. Maintenance"

10. PRESENTATION TO PROJECT STEERING COMMITTEE

Report No. 9: Suggestion for improvement of the PWD costing methods, processes, centralise costing / estimating policy function, upgrade cost estimating tools, skills

PWD Focus Group - F	
Sri R. K. Garg	CE (World Bank), Lucknow
Sri Arvind Kumar Verma	CE, Jhansi Zone, Jhansi
Sri H. R. Sonkar	Financial Controller, Lucknow
Sri Alok Darbari	EE, PD Shrawasti
Sri Virendra Yati	EE, IDS Cell, Lucknow
Sri Ashok Mahto	EE, CD – 5, Allahabad
Sri A. K. Bindal	AE, BDD – 11, Lucknow
LEA International Ltd. and LEA Associates South Asia Pvt. Ltd.	
Mr. Alan Stanbury	Team Leader
Mr. S. K. Pancholy	Contract and Procurement Specialist



Report No. 9: Suggestion for improvement of the PWD costing methods, processes, centralise costing / estimating policy function, upgrade cost estimating tools, skills

BACKGROUND

IDS / TCE Concerns:

The IDS Consultant / TCE brought out several weaknesses and deficiencies in the PWD's current costing system:

- Proper costing system is not in place whereby comparison of cost effectiveness of in-house versus outsourced works may be done.
- The unit costs are only relate to input materials, as output based cost parameters are not emphasized in the system.



BACKGROUND (contd...)**Recommendations by IDS / TCE:**

- (i) Build an effective management control around a cost centre approach for the Division.
- (ii) Follow the life cycle costing approach for the road developmental work, wherein, impact of road depreciation, ordinary maintenance and renewals are accounted for while costing for the asset.
- (iii) Maintain cost accounts
- (iv) Provide requisite support to the maintenance management system through cost accounting.
- (v) With the objective of keeping the holding cost to a minimum, include inventory valuation in the costing system.
- (vi) The cost accounting system should support transfer pricing within the organization, especially for pooled road machines and equipment.



Action Milestone:

- Improve the PWD costing methods, processes, centralize costing / estimating policy functions , update cost estimating tools, skills etc

This Report Covers:1) Costing and Cost Estimates – definitions

- Estimate
- Cost Estimate
- Project Costing
- Life Cycle Costing
- Construction contingency
- Engineers Estimate (Detailed Cost Estimate)
- Risk



2) Existing System of Costing in UP PWD

Types of Cost Estimate

- Preliminary Estimates
- Detailed Estimates
- Revised Estimates
- Supplementary Estimates



3) Comments on the existing system

- no manual or guidelines relating to preparation of cost estimates
- detailed engineering designs not based on detailed site surveys
- Basic Schedule of Rates and Standard Data Book for Analysis of Rates is out of date: based on outdated methods of construction and maintenance
- Detailed cost estimates only cover construction costs: do not consider 'life cycle approach'
- No data base with historical records of cost estimates available
- Risk management not considered
- No system for comparing estimated costs with actual costs for similar works
- Alternative solutions not considered
- Preparation of accurate cost estimates is highly skilled job but in PWD is given to Junior Engineers or Assistant Engineers
- Poor quality of Detailed Project Report affects quality and leads to cost over-runs, and disputes



4) Comments of TCE Recommendations

- Budgetary Control: Reports Nos. 16 and 28 cover this aspect with proposals to improve same
- Standard Costing System: Basic Schedule of Rates should be considered as 'standard cost' for each item

Efficiency Measurement: comparison of standard costs with actual costs

Variance: differences between standard costs and actual costs for management action

Cost Control: standard costs and actual costs need to be analysed and adjustments made to standard costs to ensure that they reflect current costs

- Life Cycle Costing



4) Comments of TCE Recommendations – continued

- Support to Maintenance Management System: as reliable cost information is obtained it must be used as input to, say, HDM 4
- Maintenance of Cost Account: to show –
 - a) how resources are used
 - b) purpose for which they are used
 - c) how well they serve the purpose
- Construction and Maintenance Costs: suggested that for major projects Contractor must give detailed programme and cash flow forecast
- Inventory Valuation: very useful where the PWD has to supply materials for execution of the Works.
- Transfer Pricing: means of costing plant and equipment transferred from one Division to another



5) Suggestions for improvements

- (i) Manual on Cost Estimating
- (ii) Field Investigations and Testing
- (iii) System for Quality Assurance of Cost Estimates
- (iv) Modify Basic Schedule of Rates
- (v) Modify Standard Data Book for Analysis of Rates
- (vi) Computerisation of Cost Estimation
- (vii) Develop Historical Data Base
- (viii) Analysis of Alternative Designs
- (ix) Life Cycle Cost
- (x) Review of Cost Estimate
- (xi) Training



PROPOSED PROCESS FOR IMPROVING THE PWD COSTING SYSTEM

1 Develop a Cost Estimating Manual

A Committee of some four to six Senior PWD Officers should be formed

Staff in should be suitably trained and an External Consultant (probably a Cost Consultant) appointed to provide leadership and guidance.

Manual for Cost Estimating should ideally include the computerisation of the cost estimating system and processes, including the establishment of a database.

Prior to any work on Manual the following steps need to be approved:

1. Drawings, Specification, and Bill of Quantities all in agreement
2. Cost elements determined and linked to Bill of Quantities and Specification



PROPOSED PROCESS FOR IMPROVING THE PWD COSTING SYSTEM

1. Develop a Cost Estimating Manual (contd...)

The framework and structure of the manual should cover the following broad issues:

Cost Estimating Guidelines and Procedures for UP PWD

Part One: Administration

Part Two: Cost Elements and Associated Costs

Part Three: External Factors Which Can Influence Costs

Part Four: The Basic Process

Training



PROPOSED PROCESS FOR IMPROVING THE PWD COSTING SYSTEM

2. Data Collection and Field Investigations: adopt IRC Guidelines
3. Quality Assurance of Cost Estimates
4. Basic Rates
5. Computerisation of Cost Estimation Process
6. Skills



PROPOSED PROCESS FOR IMPROVING THE PWD COSTING SYSTEM

7. Develop Historical Database

8. Analysis of Alternative Designs

9. Life Cycle Cost

10. Systems for the Review of Cost Estimates

11. Training

12. Cash Flow Forecasting



ACTION PLAN FOR IMPLEMENTATION

- A Development of Manual on Costing
- B Development of Detailed Guidelines for Preparation of DPR
- C Establishment of Cost Elements and Historical Cost Records
- D Create a Dedicated Cell for Review of Cost Estimates in Zone, Circle and Division
- E Strengthen the Quality Management Cell in Application of Quality Assurance Measures
- F Train PWD Field Staff in Cost Estimation

