Cash Flow Estimation for Engineering Projects using Project Management Software

Vivek C. Datey*

ABSTRACT

Organizations undertaking engineering projects as a business activity face difficulties in estimating cash flows. Each project has a unique process cycle, varying net cash position due to 'S' curve pattern of progress and different contract terms. Various mathematical, empirical or analogous cash flow estimation models have been developed by researchers for the purpose, but have not found any commercial use.

The presently available project management software works out resource based activity costs as well as period wise and cumulative build-up of project costs on accrual basis and hence does not reflect 'cash outflows, The software also does not provide for recognizing project income in terms of 'cash inflows'.

The paper proposes a method working out project cash flow estimation using the project management Software as it is; with its existing features and capabilities and without developing any macros or ad-on software.

The method is expected to be helpful to engineering construction and project industry for estimation of project cash flow and working capital requirements.

KEYWORDS: Project Cash Flow Estimation, Contractor's Cash flows, Cash Flow Management for Projects, Project Management Software.

INTRODUCTION

Estimation of cash flows is the first step in cash flow management for a business. Proficient cash flow estimation allows a company to estimate the amount of cash it will have on hand at any point of time, project the trends in cash inflow and cash outflow, and evaluate whether a shortfall or surplus in cash could potentially occur. It helps to avoid extended cash shortages caused by having a large gap between cash inflows and outflows. The company will not be able to stay in business if it does not receive payments due from clients or cannot pay the bills for any extended length of time.

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The organizations that undertake projects for their clients as a business activity - such as civil construction and engineering projects contractors - face a major difficulty in estimating their cash flows - incoming and outgoing - because,

a.   Projects are non-recurring and non-repetitive in nature and follow a unique process cycle for each project.

b.   The projects typically follow an 'S' curve pattern in its progress and the quantum of net cash position - cash deficit or cash surplus - vary from time to time as the project progresses from start to completion.

c.   The net cash position is also dependent on contract terms, supplier credit and payment schedules to sub-contracted work and differs from project to project.

Various studies carried out have attributed poor cash flow management as the most significant factor leading to project delays and contractor's bankruptcy. Hence, the estimation of cash flow for projects assumes special importance for project contractors.

Apart from the classical method developed from the 'first principles' to estimate periodic payments and receipts in a tabular form, using the project activity schedule Gantt chart as a basis, there have been various mathematical or empirical models suggested by researchers for cash flow estimation for engineering projects that take into consideration, the peculiarities of project cash flows for different types of projects and contract conditions. However, in spite of extensive research on the subject, the models have not found any commercial application.

Various Project Management Software (PM Software) capable of project scheduling, resource allocation, cost estimation and progress monitoring, still falls short of cash flow estimation. Since use one of the PM software for project planning and monitoring has almost become an industry norm today, it would be very useful if the application can be extended to working out project cash flows.

The paper therefore proposes a method and procedure to prepare project schedules by incorporating suitably modified inputs to the PM software and extract cash flow related information. This would probably be the first attempt to use standard PM software for net cash flow generation. The procedure is much simpler than the existing classical method, will save duplication of efforts in using a spread sheet software (e.g. MS Excel) along with a PM software and will enable faster and accurate updates to net cash flow position from time to time during project execution phase.

Although the procedure described relates specifically to MS Project 2010, it would be equally applicable to other PM software after taking into account the individual characteristics of the software.

Procedure can be further eased by developing suitable macros or ad-on programs.

REVIEW OF THE PAST WORK ON PROJECT CASH FLOW ESTIMATION METHODS

Previous work on project cash flow estimation can be divided under three categories:

CLASSICAL METHOD

The basic logic and procedure of the classical method can be found in the various text books on project management and is nicely illustrated in a journal article (Chen, 2007).

MATHEMATICAL MODELS

The research on cash flow management for engineering projects has focused so far mainly on development of mathematical and empirical models for cash flow forecasting.

Khosrowshahi (2001) has proposed a mathematical model for forecasting of project expenditure by identifying variables associated with the physical shapes of expenditure profiles for different types of projects. However, the model develops only the 'project expenditure' flow and suggests to be used as a basis for strategy for the contract negotiation.

Hwee & Tiong (2002) have developed computer program CAFFS (Cash Flow Forecasting System) for predicting cash flow profile of a construction project, taking into account contractual factors in a project as well as working practices and trends that affect the project's cash flow. The program also purports to reflect impact of uncertainties and risks such as excess measurement, variation of contract, cost fluctuation etc. on the cash flow profile.

Kenley (2003) has developed a 'Logit net cash flow model' based on empirical project data that uses the actual component inward and outward cash flow data in order to form the residual model. This model has adopted the Logit gross cash flow model (Kenley and Wilson, 1986) to model the

component curves. When combined, the component curves form a net cash flow model reflecting the true net cash position for each project.

Park, Han & Russell (2005) have attempted to estimate cash flows by categorization of different project activities on the basis of time lags involved between their physical occurrence of different stages and the related cash flows and identifying the characteristic movement of cumulative cash flow against time of the activity. Typical 'cash flow curves' are developed for different categories and are converted to mathematical equations for cash inflows and outflows. The overall cash flows are worked out by consolidating these equations to the project schedule.

Jarrah, Kulkarni & O'Connor (2007) have collected actual cash flow data for a sample of typical road construction projects and worked out the cumulative cash flow curves for such projects using regression analysis.

Görög (2009) has suggested a set of new measurements and indicators based on contract prices and financial accounts for the proposed 'contractor cash flow' model in line with the 'earned value' measurements and indicators in view of possible integration of both systems.

There are many more papers by researchers that try to further refine the process of cash flow forecasting to bring it nearer to the real life situation, but still have their limitations for universality in application. These cash flow models assume that only a few variables are sufficient to derive an ideal construction project cash flow curve. However, as mentioned earlier,

each project follows a unique process cycle that results in individual variation between projects that do not allow it to be fitted into a standardized model.

PROJECT MANAGEMENT SOFTWARE

Most of the project management software has the necessary features that allow each project to be planned individually without making it fit into some standardized formulae or models. It generates cost related information based on the expenditure data for material, manpower and equipment resources. It works out the project expenditure accumulated on accrual basis. Ironically, the software stipulates this as 'cash flow' although the figures are not worked out on cash basis. Users of the software unaware of this difference utilize the information for cash flow planning. Further, the PM software provides information only related to project expenditure and does not recognize project income that is very essential for working out net cash flow.

It is therefore see that in spite of being mostly manual and therefore tedious, the classical method is still popularly used for project cash flow estimation, while the mathematical and empirical models are not universally applicable and not commercially available.

The project management software interprets cash flow in an incorrect manner and therefore is not useful for cash flow projection. *It is also observed that no attempt has been made so far to use the project management software for project cash flow estimation.*

OBJECTIVE, SCOPE AND CONSTRAINTS OF THE PRESENT WORK

Objective of the present work is to develop a method to use the commercially available PM software for working out net cash flow estimates for a project. Only the modified inputs to the software and some of the outputs generated should be used to obtain sufficient information for cash flow estimation by using the existing features of the software, without any modifications to the software or without developing any ad-on programs.

Among the commercially available PM software in engineering projects industry, Microsoft Corporation's 'MS Project' software is considered for developing the method because:

a. MS project is widely and extensively used in construction and project industry due to its simplicity, user friendliness and easy availability. It performs scheduling, resource allocation, cost estimation and progress monitoring on the basis of 'Earned Value' measurement, and therefore, its use for cash flow estimation is a natural extension.

b. MS Project is flexible, adaptable, and relatively easy to learn. Majority of personnel associated with projects are trained in use of the and there will not be any additional training required to use the developed method.

c. 'MS Project 2010' version of the software has been used by the author and therefore, the description of the method is with reference to its menu, views and terminology. However, the basic principles

of the method would be equally applicable to other versions of the software as well as other commercially available project management software.

PROPOSED METHOD TO USE MS PROJECT SOFTWARE FOR CASH FLOW ESTIMATION

As was mentioned earlier, the 'cash flow' generated by MS Project is not worked out on cash basis and therefore actually shows the project's 'earned value'. MS Project also does not account for the cash inflow.

Financial 'Cash flows'; inflows and outflows; occur at specific points in time during the project unlike the progress of project activities which is continuous and gradual. The cash flow occurrences therefore, should be treated as 'events' or 'milestones' in the project schedule.

Characteristics of cash flows that arise out of different activities in different ways are first identified to create related cash flow events. The cash flow events are categorized as recurring and non-recurring. The events which occur regularly with specified frequency during the project are treated as recurring events, while the events that are occasional, not occurring with regular frequency or occur as per terms of order / contract are non-recurring.

Each of these types of cash flow generating activities and their related events are then scheduled using the basic scheduling logic of the software. In order to obtain cash flow values, differentiation between 'cost' or 'expenditure' figures and 'cash flow' figures is established (Hamburger, 1986) and appropriate cash flow values fed in to the software. This will thus give the schedule and values for 'cash outflow'.

A separate schedule is prepared for working out cash inflows since cash inflow values are not necessarily related to the project expenditure or the physical progress of activities. The cash inflow events will be scheduled according to the contractual terms for releasing payments by the client and cash flow values will be as per billing rates.

The net cash flow is worked out over the duration of the project as a difference between cash inflow and the cash outflow.

The detailed procedure for determining cash outflows and inflows is explained further. The schematic flow charts in Figure 1 and Figure 2 help in understanding the process step-by-step.

PROCEDURE FOR DETERMINING CASH OUTFLOW

FIGURE 1: FLOW CHART FOR PROJECT CASH OUTFLOW
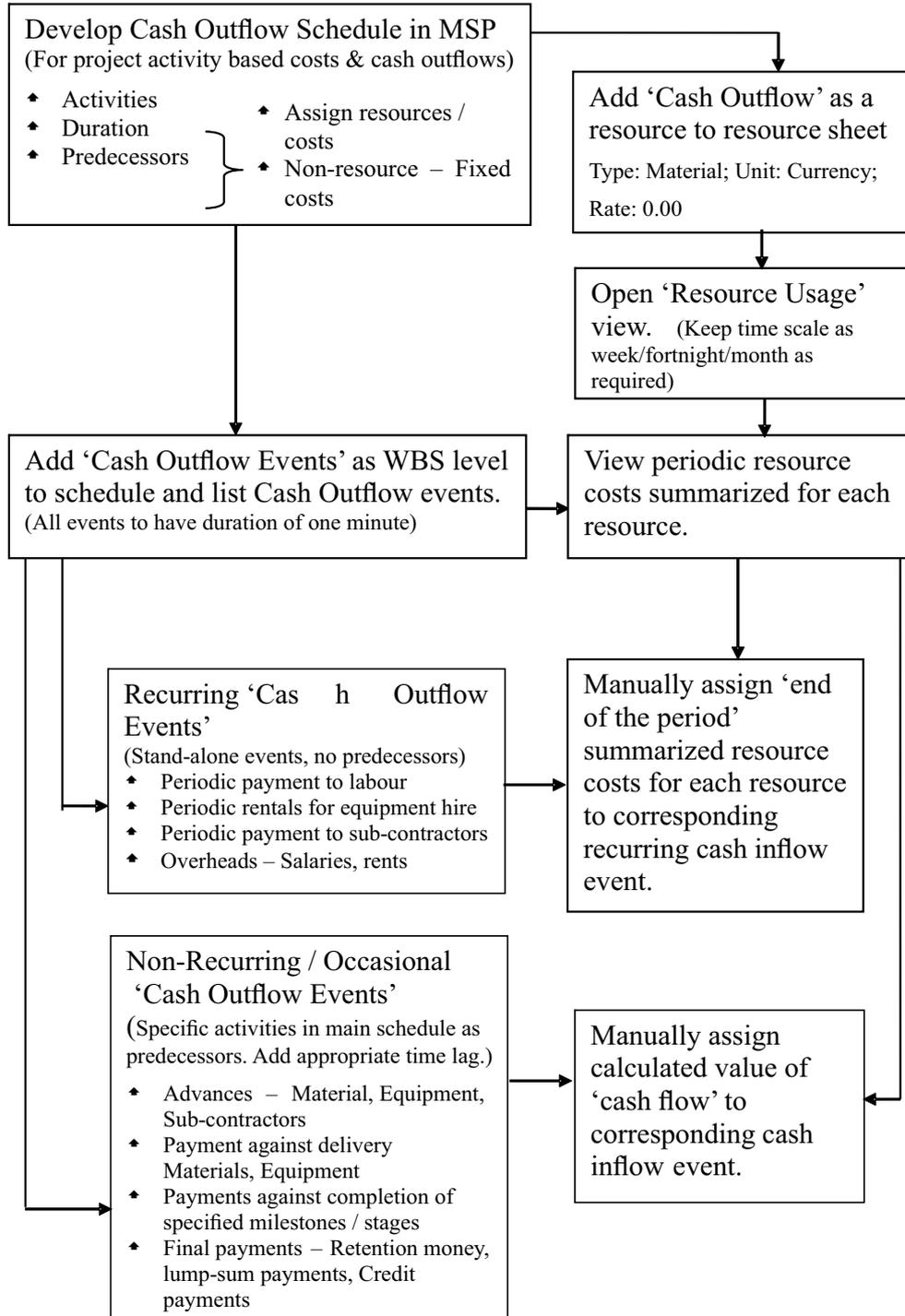
a. DEVELOPMENT OF PROJECT SCHEDULE FOR CASH OUTFLOW

Develop the basic project schedule in the software covering different activities or tasks to be performed specifying their estimated durations and linkages. It should be seen that all the activities giving rise to cash flow should be mentioned in the schedule. Define resources and their rates and assign them to individual activities so that resource costs get associated with the activities. Also assign estimated costs to the activities that have only associated costs without resources, as fixed costs.

While scheduling the sub-contracted work, the schedule should generally describe activities according to items of work and deliverables mentioned in the contract on which basis the work will be measured and billing will be done by the subcontractor. All the items of billing should be considered as 'Material' type resource with unit rates for quantities included in the 'Resource List.'

Make adjustments in the schedule by resource leveling and finalize the baseline schedule. *(The described process is the normal process for project schedule development in MS Project software and needs no further elaboration for regular users of the software.)*

b. CREATION OF 'CASH OUTFLOW' EVENTS AND ADDING TO THE SCHEDULE

In order to recognize cash outflows occurring either periodically or related to specific project activities / events, a schedule for 'cash outflow events' is created under a separate WBS heading as 'Cash outflow'. Different cash outflow events are given in **Annexure 1**.

For the periodic cash outflows, 'recurring events' are created for each resource that is being paid periodically.

For non-recurring individual cash outflow events, a link is established between the related project activity / event and its corresponding cash outflow event with appropriate relationship and time lag equivalent of the difference of timing between the project activity / event and cash flow event.

The recurring cash flow events need not be linked since they are not associated with any specific project activity, but occur with specified frequency.

All the cash outflow events are assigned the duration equal to One minute. *(As per normal convention of the scheduling logic, the 'events' have 'zero' duration and do not consume any resources. Hence in MS Project software, an activity with 'zero' duration is treated as an event and no resources can be assigned to it. Hence the specified 'cash outflow events' are given very insignificant duration as compared to the overall project duration, which can be considered 'zero' for all practical purposes, but can be assigned resources.)*

c. DEFINE 'CASH OUTFLOW' AS A NEW RESOURCE

In the 'resource sheet' a new 'Material' type resource is created and named as 'Cash Outflow'. Unit for this resource is named same as the currency unit being used for the project (e.g. Rupee). 'Standard rate' and 'cost per use' is retained as zero and 'Accrue at' chosen as 'End'.

d. ASSIGN CASH FLOW VALUES TO CASH OUTFLOW EVENTS

For assigning cash flow values to the cash outflow events, the following two types of procedures are recommended depending on the nature of cash flow.

i PROCEDURE FOR CASH OUTFLOWS FOR RECURRING CASH OUTFLOW EVENTS

View periodic costs: On the basis of labour and equipment resource assignments in the project schedule, the activity costs are established as budgeted costs for the activity. Similarly, specified item rate costs and item quantities for the sub-contractor work in project schedule are established by considering each contract rate item as 'Material' type resource.

The 'Resource Usage' view shows the periodic cost for each resource on different activities as well as the resource-wise summary periodic cost for all activities assigned to the resource. Choosing the appropriate unit for the bottom 'Time Scale', (e.g. 'week' as a unit gives the weekly labour costs and 'month' as a unit gives cost of work during the month by sub-contractor.) The overhead costs such as staff salaries etc. that are spread over the project duration are also seen on monthly basis.

View end of the period costs: The payments that accrue at the end of the period are the total costs incurred during the specific period. For example, as per the normal practice in the industry, daily wage labour and hiring charges for the equipment are paid at the end of the week for number of days they have worked during the week. Hence the total weekly labour costs and equipment hiring charges as worked out in the earlier step above also represent total costs accrued as of end of the week.

Assign cash outflow values to cash outflow events: The accrued cash outflow amounts at the end of the given period are assigned to the specific cash outflow events as 'cash outflow' resource. For example, in case of labour payments, cash outflow events are the recurring events titled as payments to the labour. The weekly cash outflow units equivalent to amounts as given for labour cost by the weekly 'Resource Usage' table are assigned to the weekly cash flow events.

View periodic cash outflow: Once the cash outflows are assigned to the cash outflow events, the 'Resource Usage' table reflects the periodic cash outflow for different activities and also for the total project.

View cumulative cash outflows: Similar to the periodic cash flows, cumulative cash flows at the end of every period can also be viewed for each resource. By totaling the resource-wise, the periodic cumulative cash flow is worked out.

ii PROCEDURE FOR CASH OUTFLOWS NON-RECURRING CASH OUTFLOW EVENTS

Assign cash outflow values to cash outflow events: Cash outflow values worked out as per the terms of the contract or purchase order are assigned to specific cash outflow events directly.

View periodic cash outflow: Once the cash outflows are assigned to the cash outflow events, the 'Resource Usage' table reflects the periodic cash outflow.

Determine cumulative cash outflows: Once the periodic cash flows are established as above, period wise cumulative cash outflows are worked out. The cumulative cash outflows are ultimately used to find the 'net cash flows' during the project tenure.

PROCEDURE FOR DETERMINING CASH INFLOW

FIGURE 2: FLOW CHART FOR PROJECT CASH INFLOW
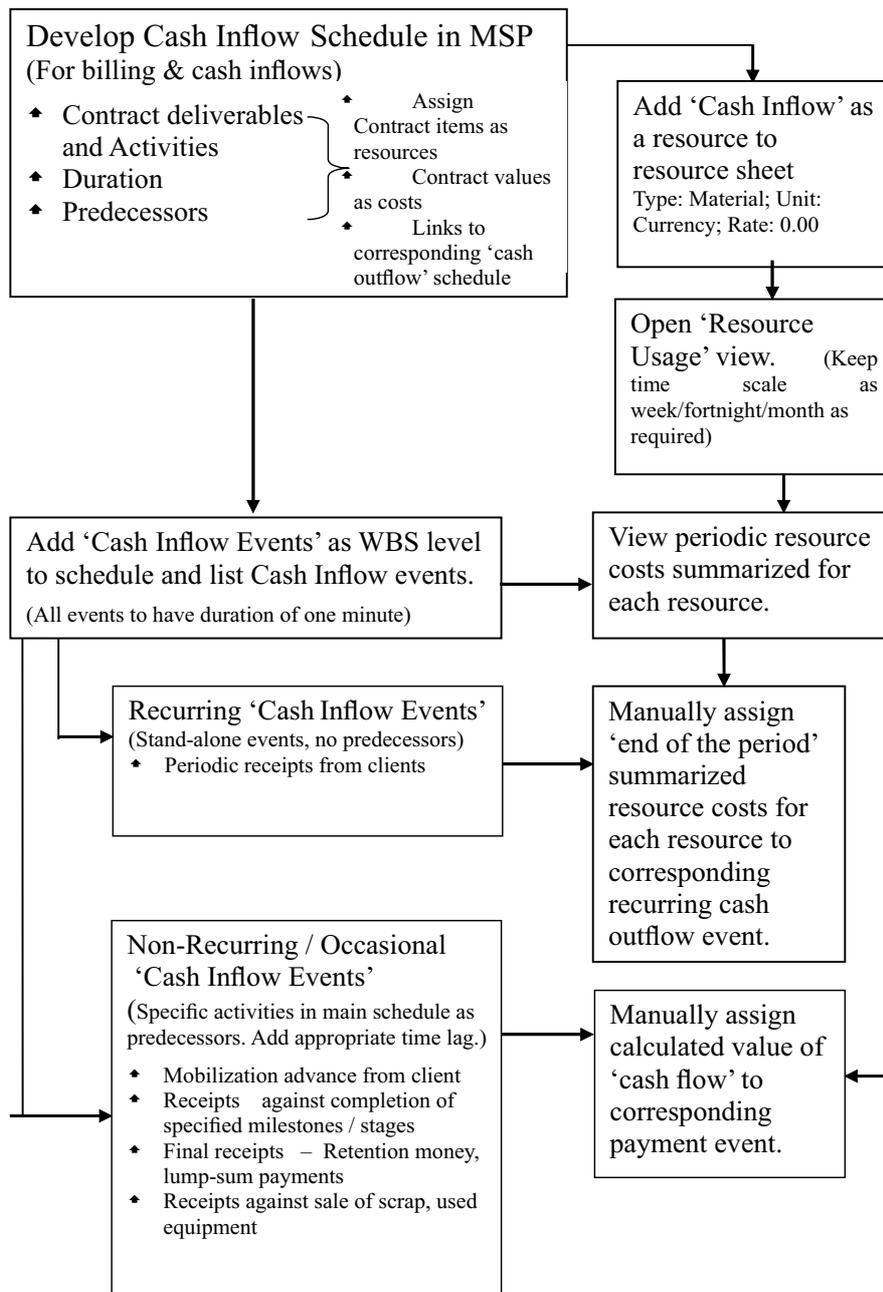
Procedure is very much similar to determination of cash outflows as explained above.

a. DEVELOPMENT OF PROJECT SCHEDULE FOR CASH INFLOW

Since billing values to the client include the profit margin, they are different than the values established in the 'cash outflow' schedule. Hence a parallel schedule is established for cash inflow determination. The schedule should cover activities according to different items of work and deliverables as mentioned in the contract with the client on which basis measurements and billing to the client is done. Many of these items would be same as those in the cash outflow schedule and they are copied directly.

All the items of billing are considered as 'Material' type resource and are included in the 'Resource List'. (Similar to the sub-contracted work in cash outflow schedule) The rates for the items are as per the contract on the basis of which billing to the client is done.

b. CREATION OF 'CASH INFLOW' EVENTS AND ADDING TO THE SCHEDULE

In order to recognize cash inflows occurring either periodically or related to specific project activities / events, a schedule for 'cash inflow events' is created under a separate WBS heading as 'Cash inflow'. Different cash inflow events are given in Annexure 1.

For the periodic cash inflows, 'recurring events' are created for each receipt that occurs periodically.

For non-recurring individual cash inflow events, a link is established between the related project activity / event and its corresponding cash inflow event with appropriate relationship and time lag equivalent of the difference of timing between the project activity / event and cash flow event.

The recurring cash flow events need not be linked since they are not associated with any specific project activity, but occur with specified frequency.

All the cash inflow events are assigned the duration equal to One minute for the reasons explained earlier for cash outflow events.

c. DEFINE 'CASH INFLOW' AS A NEW RESOURCE

In the 'resource sheet' a new 'Material' type resource is created and named as 'Cash inflow'. Unit for this resource is named same as the currency unit being used for the project (e.g. Rupee). 'Standard rate' and 'cost per use' is retained as zero and 'Accrue at' chosen as 'End'.

d. ASSIGN CASH INFLOW VALUES TO CASH INFLOW EVENTS

For assigning cash inflow values to the cash inflow events, the following two types of procedures are recommended depending on the nature of cash inflow.

PROCEDURE FOR ASSIGNING CASH INFLOW VALUES FOR RECURRING CASH INFLOW EVENTS

i **View periodic income accruals:** On the basis of 'contract item' resource assignments in the project schedule, the income accruals are established as budgeted incomes for the activities.

The 'Resource Usage' view shows the

periodic income accrual for each resource item on different activities as well as the resource-wise periodic summary income for all activities assigned to a resource. Choosing the appropriate unit for the bottom 'Time Scale', (e.g. 'week' as a unit gives the weekly billing value, 'month' as a unit gives billing of work during the month)

ii   **Establish end of the period income accrual:** The income that accrues at the end of the period is the total billable value during the specific period. Hence the total monthly billable value as worked out in the earlier step above, also represent total income accrued as of end of the month.

iii   **Assign cash inflow values to cash inflow events:** The accrued income amounts at the end of the given period are assigned to the specific cash inflow events as 'cash inflow' resource.

iv   **Establish periodic cash inflow:** Once the cash inflows are assigned to the cash inflow events, the 'Resource Usage' view reflects the periodic cash inflow for different contract items and also for the total project.

v   **Establish cumulative cash outflows:** Once the periodic cash inflows are worked out, cumulative cash inflows can be ascertained.

PROCEDURE FOR CASH INFLOWS FOR NON-RECURRING CASH INFLOW EVENTS

i   **Assign cash inflow values to cash inflow events:** The income amounts arising out of

specific activities / events are assigned to the specific cash inflow events as 'cash inflow' resource.

ii   **Establish periodic cash inflow:** Once the cash inflows are assigned to the cash inflow events, the 'Resource Usage' table reflects the periodic cash inflow for different activities and also for the total project.

iii   **Determine cumulative cash inflows:** Once the periodic cash inflows are established as above, period wise cumulative cash inflows also can be viewed in 'resource usage' table. The cumulative cash inflows are ultimately used to find the 'net cash flows' during the project tenure.

DETERMINATION OF NET CASH FLOW AND WORKING CAPITAL REQUIREMENTS

NET CASH FLOW

The difference between cumulative cash inflow and cumulative cash outflow at any point of time is the net cash position at the given time. A positive value indicates cash surplus and the negative value indicates cash deficit.

WORKING CAPITAL REQUIREMENT

Cash deficit at any given point of time needs to be supplemented by external source of fund such as borrowings from financial institutions or company's own reserves. Knowledge of the extent and timing of cash deficit during the project at the planning stage enables the company to make prior planning and arrangements for meeting the cash deficit and avoid adverse effects of inadequate cash flow on the project.

ADVANTAGES OF THE PROPOSED METHOD

a. Use of the PM software extended to incorporate cash flow working will not need separate development of cash flow statement in a spreadsheet package by duplication of efforts.

b. Since the PM software is also capable of quickly reflecting changes in schedules, resource allocation and usage as well as the expenditure patterns during periodic updating of the status of the project, control on schedule, cost and cash flow can be exercised.

c. Engineering project contractors need not invest into any specialized software for project cash flow estimation as they can use the PM software already installed with them.

d. Reliability and accuracy of the cash flow derived by the proposed method will be better than the classical method.

e. Personnel using the PM software will be able to adopt the proposed method quite easily and there will be no need for additional training.

f. Project managers will be able to give a better idea of cash and working capital requirements to the finance executives for making appropriate arrangements for the same.

CONCLUSION AND SCOPE FOR FURTHER DEVELOPMENT

The proposed method illustrates how different limitations of the present PM software can be overcome by certain improvisations for working out project cash flows. Still the process has remained a little complicated since certain data generated by the software relating to cash flows needs to be fed again manually to the same schedule. However, it would be still preferred over the fully manual method popularly used at present.

It may be possible to develop macros to directly pick up the values for project expenditure calculated by the software and assign them to corresponding cash flow events. This needs to be further explored.

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ANNEXURE 1

PROJECT CASH FLOW EVENTS

Typical Project Cash Outflow Events:

a.   Advance Payments:

● Advance to material suppliers (Upto 10% of order value on placement of order)

● Advance to machinery, plant and equipment suppliers (20% to 40% on placement of order immediately or within specified period)

● Mobilization advance to sub-contractors (10% to 20% on issue of contract with or without bank guarantee)

b.   Payment against delivery:

● Payment for material against pro-forma invoice / LC / RR / LR / within specified period (Balance payment)

● Payment for equipment against pro-forma invoice / LC / RR / LR / within specified period (Balance payment less retention against performance guarantee)

c.   Payments to labour:

● Periodic payment to daily wage labour (weekly/monthly number of days worked)

● Periodic payment to contract labour (weekly/monthly quantity of work done)

d.   Payments for equipment on hire:

● Periodic rental to equipment owner for equipment on long lease (Monthly rent)

● Payment per use (Daily rental for number of days used plus 'per use' charge)

e.   Payments for overhead expenses:

● Salary payments to project staff (Monthly fixed)

● Site running expenses (day-to-day office expenses)

f.   Payments to sub-contractors:

● Periodic payment against running bills on rate contracts (less of advances and retention)

● Stage payment on completion of specified stages/milestones (less of advances and retention)

● Payment against delivery of specified equipment modules in EPC contracts

g.   Final payments:

● Payment of retention money (5 % to 10 % - released immediately against bank

guarantee or within specified period after completion of order or contract)

● Payment for erection and commissioning of equipment (5 % to 10 % - released immediately against bank guarantee or within specified period after completion of order or contract)

● Payments against lump-sum contracts (On completion of contract less advance if any)

● Payment for materials supplied on credit (At the end of credit period)

TYPICAL PROJECT CASH INFLOW EVENTS

Cash inflows are mainly from the following three categories

a.   Receipts from client as per contract:

● Mobilization advance (Usually 10 % of contract value)

● Periodic or stage payment against the bills raised for completed work less of mobilization advance and retention (Usually 70 % ~ 80 % ad-hoc on bill submission and balance within 7~15 days after bill certification)

● Payment against material stock (some contracts provide for payment against material costs available in stock with contractor on date of billing)

b.   Receipts against sale of scrap:

● Payments received against sale of extra material and scrap (Usually at the end of the project)

● Payment received against sale of used

equipment (Usually at the end of the project)

NOTES

1   'S' Curve refers to a typical manner in which projects progress exponentially at the initial stages, and slow down nearing the completion giving rise to a 'sigmoid' curve or an 'S' shaped curve.

2   Accrual system of accounting recognizes economic events regardless of when cash transactions occur. The general idea is that economic events are recognized by matching revenues to expenses (the matching principle) at the time in which the transaction occurs rather than when payment is made (or received).

3   Cash system of accounting is accounting method that recognizes revenues and expenses at the time physical cash is actually received or paid out. This contrasts to the other major accounting method, accrual accounting, which requires income to be recognized in a company's books at the time the revenue is earned (but not necessarily received) and records expenses when liabilities are incurred (but not necessarily paid for).

4   Microsoft Project ®, Primavera ® are some of the commercially available software.

5   Earned Value by definition, is the Amount equivalent to the budgeted expenditure for the work completed.

6   In financial terms, it is necessary to differentiate 'expenditure' from 'cost' and 'cash flow'. (Hamburger, 1986).