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CASH FLOW FORECASTING MODEL USING MOVING WEIGHTS OF COST CATEGORIES FOR GENERAL CONTRACTORS ON JOBSITE

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ABSTRACT
This research introduces the development of for a project-level cash flow forecasting model in construction stage based on planned earned value and cost from a general contractor's view on a jobsite. Previous most models have been developed to assist contractors in their pre-tender or planning stage cash flow forecasts.

The key to cash flow forecasting at the project level is how to build a cash-out model. The basic concept is to use moving weights of cost categories in a budget. The cost categories are classified to compile resources with almost the same time lags. Time lag, as used here, is based on contracting payment conditions and credit times given by suppliers or venders. For cash-in, net planned monthly-earned values are simply transferred to the cash-in forecast, to be applied there with billing time and retention money.
Validation of the model involves applying data for four real projects in progress for 12 months. Through comparative analyses of the simulation results based on the proposed model and results based on existing models, the proposed model is more accurate, flexible and simple than traditional method for construction jobsite employee who is not oriented financial knowledge.

KEYWORDS
Cash Flow Forecasting, Moving Weights, Cost Categories

1. INTRODUCTION

Cash is the most important of the construction company's resources, because more construction companies fail due to lack of liquidity for supporting their daily activities than because of inadequate management of other resources (Singh and Lakanathan 1992; Navon 1994b).

Russell (1991) stated that an excess of 60% of construction contractor failures are due to economic factors. Considering the real business world in the construction industry, various forecasting methods may be applied to cash flow.

The technique proposed by Sears (1981) is based on manual integration of the schedule and cost items, i.e., the integration is to reflect the relationships between activities and cost items. However, it requires considerable manual work. In addition, the method does not consider the time lag between the use of a cost item and the payment for it. Reinschmidt and Frank (1976) proposed a model for cash flow forecasting in the early planning stage of a project. However, this model also does not consider the time lag to cost, which is important in cash flow forecasting.

The model of Navon (1995, 1997) proposed automatically integration of the B.O.Q (Bill Of Quantity), the estimate and the schedule associated with lower level (resource level). However, in this case, if either the B.O.Q or the schedule is changed due to change order, design change, etc., integration of them is more complicated and time consuming. Moreover, the main obstacle to automating the integration process is compatibility between cost items of the B.O.Q. and activities of schedule.

Gates and Scarpa (1979) and Peer (1982) developed cash flow models in the conceptual and planning stages using algebraic formulations and polynomial regressions. However, none of these models considered time lags to the costs and earned values.

Ashley and Teicholz (1977) suggested a cash flow forecast based on detailed methods for cost flow. They classified the direct cost by a number of cost categories such as labor, materials, etc., which are specified as percentages of total cost. This approach is a very reasonable because it considers the nature of budget and cost. However, the problem is that each of these cost elements is applied to a fixed percentage of total cost over the project duration. Moreover, this model also does not consider the effect of time lags on the costs.

The merits of traditional models as tools of cash flow planning are questionable when applied during the construction stage. In reality, during construction there are many factors that may affect the cash flow such as time delays, cost overruns, unconfirmed earned values, change orders, changes of cost plan elements, etc. (Bennett and Ormerod, 1984).

The key points of cash flow forecasts is how accurate, flexible, and comprehensive to be calculated and considered uncertain factors such as time delay, cost overrun, variation of cost and earned value between plan and actual. Plan is only plan with including uncertainty. There is no project in progress that is in complete accordance with initial planning. This does not mean there is no need for planning of the cash flow. Cash flow is a reality. A cash flow estimate that includes the uncertainties of the construction business and jobsite procedures will be more precise than a cash flow forecast based on the pre-estimate or estimate stage. Even though construction is progressing, cash flow forecasts for projects cannot be determined precisely.

As a result, First, they are not based on the construction stage but on only the planning or preliminary stages in the project delivery process. Second, they do not consider time lags for the costs and earned values in forecasting cash flow. Third, with regard to integration of cost items and activities, they are not compatible with each item and are rather complicated depending on when change factors occur in the construction stage.

2. JOBSITE CASH FLOW FORECAST MODEL

2.1 Structure of Construction Budget

A budget structure in construction projects is constituted of cost accounts such as bills, sections, items and resources. A budget is a plan for allocating resources (Meredith and Mantel 1995). Hendrickson and Au (1989) identified that allocation of a cost to the budget may be used to develop a cost function of an operation. The basic idea in this method is that each expenditure item can be assigned to particular characteristics of operation. Ideally, the allocation item of joint costs should be causally related to the category of basic costs in an allocation process. In construction projects, the accounts of basic costs may be classified as labor, material, equipment, subcontractor, and general office overhead.

Generally, the ratio of cost types for general contractors is such that subcontract costs are 50% to 70%, material costs are 25% to 35%, labor costs are 5% to 15%, equipment costs are 10% to 25%, and indirect costs are 5% to 15%. Much of the construction work on a typical jobsite is performed by subcontractors who are awarded contracts by the general contractor (Oberlender 2000). To reduce job-management cost, the general contractor always considers employing subcontractors to be allocated specific work sections of total project. In planning stage, the keys to cash flow forecasting are how costs are to be classified and time lags to resource of income and expenditure are to be calculated.

2.2 Cash-Out Model

Time Lag

The key to cash flow forecasting at the project level is how to build a cash-out model. All resources to be incurred to costs in a budget have different time lags. They are subjected to contracting procedures and a corporation's payment policy to other organizations. Cash-out forecasts are costs to be applied with time lags. Cost categories are classified to compile resources with almost the same time lags. Time lag, as used here, is based on contracting payment conditions and credit times given by suppliers or venders.

Ahuja and Walsh (1983) also insist that there are delays between the dates of costs incurred and the dates of payment due. These delays will vary depending on resource types and credit arrangements negotiated with subcontractors and suppliers. This theory is maintained by many previous researchers (Peterman 1973; Ashley and Teicholz 1977; McCaffer 1979; Trimble 1982; Kenley and Wilson 1989; Navon 1995; Kaka 1996).

Different cost categories are defined for materials, labor, equipment, subcontractors, expenses (site overhead), main materials, and depreciation items since difference these cost categories generally have different time lags. However, if additional cost categories are needed, they can be classified.

As mentioned before, in a general contractor budget, the subcontracting portion is 50% to 70% of the total budget. Since payment conditions of subcontracts are controlled by general contractor policy, this means that there is 50% to 70% certainty in cash flow forecasting regarding time lags. The only problems are how to determine time lags of other cost categories and how to plan a budget for each month.

Jepson (1969) has already suggested that net cash flow for individual projects must be derived from "component" curves of inflow and outflow profiles. Fondahl and Bacarreza (1972) claim that total costs can be broken down as to category since different cost resources may have different cost curves or different time lags related to their payment.

Moving Weights of Cost Categories

Ashley and Teicholz (1977) developed five cost curves for cost categories in their highway construction project. Fondahl and Bacarreza (1972) also applied three cost curves to their school project. "Curve 1" is based on the assumption that rate of expenditure will be uniform over the project duration. "Curve 2" assumes that only 25% of the total cost is incurred during the first half of the project duration and the remaining 75% in the second half. "Curve 3" assumes that 75% of the total cost is incurred in the first half of project duration. In their research, only field overhead and home office overhead costs were applied to "Curve 1", i.e., only these costs were assumed to be incurred at a uniform rate over the project duration.

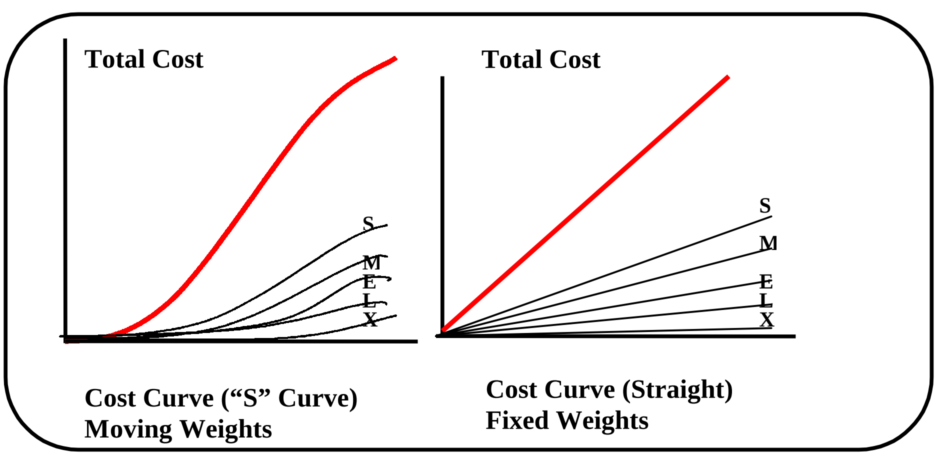

Figure 1: The Concepts of Weights of Costs during the Construction Period

Consequently, any cost categories other than overhead and home office overhead were not incurred at a uniform rate over the project lifetime. Unless the curves of all cost categories are uniform, the relative weights of the different cost categories should be changed whenever costs are incurred over the project duration. If weights of cost categories are uniform over the project duration, curves of all categories should represent straight lines.
The concepts of moving weights and fixed weights are illustrated in Figure 1.

Wheelwright and Makridakis (1980) have claimed that when the basic pattern changes, the accuracy of a forecasting technique depends on how well it can forecast the future. The procedure must identify the change and then alter the forecast accordingly including the change. That is a starting point for this model regarding cash-out forecasts. This characteristic of a budget during the construction period is illustrated in Figure2.

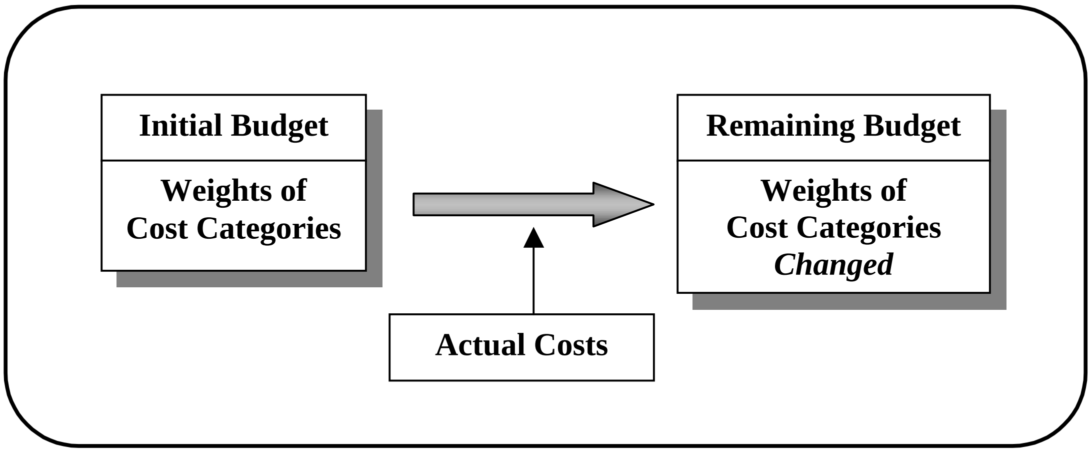

Figure 2: Characteristic of a Budget during the Construction Period

The percentages of the cost categories incurred, relative to the total costs in each month, probably will be different from initial estimated percentages of cost categories. Therefore, whenever costs are incurred in a month, weights of cost categories relative to the remaining budget shall be changed, even though neither the overall budget (the forecast total cost) nor the planning for execution is changed. Moreover, if a change of project amount or project duration occurred due to a change order or a change of contract conditions, weights of cost categories shall be changed (Park 2001).

Consequently, this implies that the next weight of a cost category to be applied will be changed in accordance with the cumulative actual cost and the remaining budget. Thus, these "the moving weights" will be continuously changed over the project duration to pertain to the remaining budget. Applying moving weights of cost categories to the remaining budget in a month (time series) is to reduce uncertainty of forecasting cash-out for the remaining duration of the project.

2.3. Cash-In

Billing Time
Generally, earned values will be received on a monthly basis or based on billing terms, but planning of earned values on a jobsite is established by monthly figures. Earned value planning is the basis for estimated cash-in values in actual cash flow analysis. Net planned monthly-earned values are simply transferred to the cash-in forecast to be applied there with appropriate time lags. The billing period, the time between the dates of bill submittal and the progress payment receipt, is stipulated in the contract. If a payment delay occurs due to the owner's circumstances, the billing time of cash-in can be adjusted in this model. In practice, billing terms in the contract should provide for a billing schedule for owner and contractor, but those terms can be applied variously depending on the owner's financing situation.

Retention Money
Cash-in planning should consider the effects of retention money and the billing period on earned values. The retention money is based on a percentage of retention stipulated in the contract. As described in Chapter 3, a

cumulative cash-in curve is obtained from the cumulative earned value curve by applying a retention rate and billing period. Generally, contractors can improve cash flow by providing 10 percent retention schedules in contracts with subcontractors. Then, the retention money would be released when construction is completed and accepted.
If cash-in is properly planned and manipulated by a model, it will supply the funds necessary to meet the cash requirements of the project without borrowing from other organizations.

2.4 Model Process

• Step 1: Input planned earned values and budget to each month, cost categories, weights, and time lags.
The model algorithm is designed to facilitate changes through a user-oriented input language. If more cost categories due to different time lags of different cases are required, the user can classify separate cost categories.
• Step 2: Automatically calculate new weights to cost categories reflected on actual cost and forecast cash flow such as cash in, cash out, cumulative cash flow, and capital cost.
This model is based on moving weights of each classified cost category in every month. Moving weights is that weight to be applied to next month that is adjusted and calculated by deducting actual cost from initial budget to the individual classified cost category by every month. Therefore, weights of each budget of individual cost category to remaining budget is to be changed every month.
• Step 3: Recalculate planned earned values and budget for each month.
Whenever deviations between planned and actual costs and earned values occur, they are automatically distributed to planning over the remaining duration if needed. If deviations between them are much more or less than expected, the project manager must modify the initial planning to forecast cash flow.

3. ASSUMPTIONS AND LIMITATIONS

3.1 Assumptions

- In the initial time earned value planning to the contract amount and cost planning to the budget are not automatically generated each month, but only made independently by engineers on the jobsite by their own method of planning. This model only continuously updates deviation between actual and planned data if necessary.
- Time lags of cost categories are based on corporate historical data and company policy.
- Cost categories classified at the start of a project have to continuously be used in order to maintain the degree of the accuracy in moving weight over the project duration.
- This model is to forecast cash flow values at the closing of each month (last day of the month).
- Depreciation of company owned equipment is included in actual cash transfer incurred cost in order to show cash flow in project-level.
- Home office overhead is not considered in this model since that is not generally considered as a cost that may be billed directly on a jobsite. That is incurred at the company-level.

3.2 Limitations

- Model is dependent on to planning of cost and earned value. If planning of cost and earned value are not accurate, forecasting cash flow would not be accurate.

- Regarding release of retention money, it can be applied to depending on duration of subcontract.

4. VALIDATION OF MODEL

4.1 Introduction

To verify the model, it is performed simulation using experimental data and four actual projects in progress. Comparative analyses of the simulation results based on the proposed model and results based on existing models are performed.

4.2 Simulation Experiments for Model

A simulation template is implemented in a common spread package, Microsoft Excel™, for the simulation experiments. The project used for the simulation experiment has duration of 6 months, contract amount of USD 550,000, and budget of USD 520,000. To simulate the model, two types can be examined:

1) Contract amount and budget fixed over project duration.
Planned data, earned value and cost, and actual data in each month are not changed (Type 1).
Planned data, earned value and cost, and actual data in each month are changed (Type 2).
2) Contract amount and budget changed over project duration.

To simulate the dynamic nature of project, 1.2) case can be applied the second case (2)). Considering different time lags of cost categories, cash flow is calculated in 10-day increments. Fixed Weights Method (an existing model) applied fixed weights to cost categories over project duration, and Moving Weights Method (a new proposed model) applied different weights at each month using the new algorithm. The results of these two models were then compared to show the accuracy and consistency of the model.

To simulate the dynamic cash flow forecasting, simulation experiments are composed of 10 simulation projects and 7 times, from after start month (0 month) to after 6th month, for each project so that a total 70 simulation experiments per each method are accomplished. As a result, since 2 types of 2 methods are applied, the experiment is simulated a total 280 times. Actual cost to individual cost categories and earned value are simulated in each month. Data for every month forecasting cumulative cash flow are compared to the final cumulative cash flow (after 6 months).

4.3.Simulation Actual Data for Model

Four actual projects include one building project and three civil projects, with data compiled over duration of 12 months (from Sep. 2000 to Aug. 2001) for each project.

The simulations were conducted 13 times from start time (0 month) to 12 month per each method for individual projects and evaluated by the two methods, M.W.M and F.W.M., in order to compare the accuracy of forecasting cash flow. In addition, two types of simulations are performed on each project in order to compare the accuracy of forecasting models. Therefore, 208 total simulations were performed for four projects, which are 52 simulations per each project.

In comparative analysis the results of forecasting are applied to cash flow each month instead of cumulative cash flow forecasting applied previously in experiments since previous cash flow affects subsequent cash flow.

To compare the nature of the two models, M.W.M and F.W.M, simulations are performed as follows:

F.W.M model
The F.W.M model is simulated using fixed weights for cost categories that are initially classified and applied to each month over 12 months regardless time series.

M.W.M model
The M.W.M model is simulated by moving weights for cost categories that are applied to the total remaining budget in each month over 12 months. Therefore, the weights of individual cost categories in M.W.M are applied to different weights each month.

To compare the accuracy of two models, M.W.M and F.W.M, simulation is performed as follows:

Type 1 Simulation
Type 1 is the type where planned data and actual data are identical data each other. This type is used to determine the reliability of the model and compare two methods under ideal conditions since planned data is one of the most critical variables in this forecasting cash flow model.

Type 2 Simulation

Type 2 is the type where planned data and actual data are different as reported by the jobsite for 12 months. In this case, the uncertainty of the construction job site is involved and the effect of planned data on the forecasting cash flow is considered. This type reflects the real construction situation but some problems were encountered during model verification. Planned data should have been regularly updated. Therefore these cases have to consider errors related to planned data under some assumptions.

4.4 Evaluation

Experiments

Based on the results of M.A.D for simulations for 10 experiments that were run 50 times per model, M.W.M results are accurate, from 4.8% to 71%, than F.W.M. Eventually comparing M.W.M to F.W.M with M.A.D, M.W.M is on average 26.5% more accurate than F.W.M for experiments.

Actual Data

1) Reliability

It is indispensable for managers to determine the level of accuracy of their data before using the model for forecasting. Kenley and Wilson (1986) and Kaka and Price (1991a) suggested that in the construction industry, the error range of the forecasting is within ± 3% of the contract amount. This is considered an acceptable limit and demonstrates the reliability of the model.

The error range of the forecasting is 0.23% to 0.6%, with an average of 0.38% for 4 projects in type 1, and 0.82% to 2.78%, with an average of 1.79% for 4 projects in type 2. In spite of considering errors in planning data, the result is a reasonable figure attained by applying the model for forecasting.

2) Accuracy

The result of accuracy tests in comparing the two models is that M.W.M is more accurate than F.W.M. In the type 1 the accuracy is –2.64% to 65.04%, with an average of 31.57%, higher than F.W.M in the ideal condition, where the planning is established well reflected on the construction jobsite, and continuously updated.

The result of the accuracy test comparing two models is that M.W.M is more accurate than F.W.M. In the type 2 the accuracy is –0.35% to 4.54%, an average of 1.75% higher. In this case, planning has remained for 1 year without any update of construction variations that change uncertainties into certainties. Therefore, the errors of planned and actual data as shown Table 6.10 have to be considered when measuring accuracy.

As a result the degree of accuracy of M.W.M averages 16.77% (17.21%) that is more accurate than F.W.M in simulation of four projects.

5. CONCLUSIONS

A simple cash flow forecasting model (M.W.M) was developed to help general contractors on jobsites forecast cash flow during the construction stage. The model was based on the general procedure of construction jobsites and the nature of the general contractor’s budget. The model included new methodology that was not considered by previous researchers. The validity of the model was tested by experimental data and actual data from four projects in progress. Moreover, the model was validated by comparing the results of the model with other models suggested by previous researchers.

Finally, the model was demonstrated to be a simple, fast, flexible and accurate forecasting tool for the individual project that can be used by general contractors who appreciate the importance of cash flow forecasting during the construction stage.

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