Predicting project duration and cost with a spreadsheet

Despite the advent of sophisticated project-management software, many construction projects still run over time or budget and then find their contingencies wanting. **Albert Hamilton** of the National Centre for Project Management at Middlesex University introduces a simple probability-based alternative using spreadsheets, which calculates the likelihood of particular costs and dates being met.

Many organisations that sponsor projects traditionally add an arbitrary figure to a project's most likely cost budget to cover unknowns. However, contingencies on project duration are seldom if ever considered. Neither practice is satisfactory and should be discontinued.

Based on recent research it would appear that project constraints of staying within the allotted time and keeping within the prescribed budget are still not being satisfactorily achieved. Early prediction of project-delivery dates and of total cost for projects is fundamental in establishing affordability and the baseline against which performance can be measured.

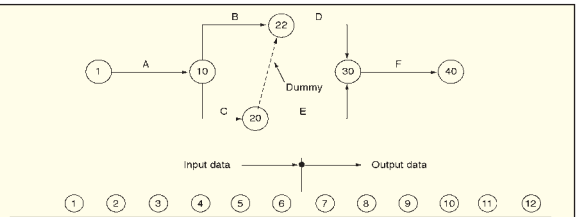
Addressing the issue of project constraints will not alone solve the issue of improving project delivery. However, accurate predetermination of these constraints is necessary as a starting point for fundamental reform in how to manage capital-works projects. A basic method is proposed here that will help to address the problem.

Using ranges and probabilities

In the early stages of a project's life, when there is wide variance in expected completion cost and forecast duration, the sensible approach is to develop predictions based on range values for the significant constraints. Predetermining duration and cost requires an approach that includes recognition of the significance of uncertainty in time and cost outcomes of individual project activities. In other words, the issue of discrete values for these variables needs to be replaced by ranges and probabilities.

Engaging stakeholders to predict optimistic, most likely and pessimistic values for any project activity time duration and budget cost will—along with an accurate assessment of which activities precede and which activities succeed—offer the means to determine ranges of a project's out-turn duration and cost.

Providing a project has a large number of activities, the 'central-limit theorem' can be used to link probability to achieving certain time and cost outcomes. Central-limit theory assumes that the mean of the sum is equal to the sum of the means of each activity's probability distribution. It also assumes that the variance of the sum is equal to the sum of the variances of each distribution, and that the probability distribution of the sum is a normal distribution regardless of the shape of the individual distributions.



	1	2	3	4	5	6	7	8	9	10	11	12
	Duration (days)			Cost (mu)			Time			Cost		
Act	a	b	c	o	m	p	te	σ	σ^2	Ce	σ	σ^2
A	5	6	8	5500	6000	7800	6.16	0.50	0.25	6217	383	146944
B	7	10	14	4200	5000	8750	10.16	1.66	2.76	5492	758	575069
C	10	12	15	5300	6000	12000	12.16	0.83	0.694	6883	1117	1246944
D	5	8	9	5600	8000	9400	7.33	0.66	0.44	7833	633	401111
E	5	6	8	5000	6000	7950	6.16	0.50	0.25	6158	492	241736
F	3	4	7	7500	8000	10500	4.33	0.66	0.44	8333	500	250000
Σ					39000					40916		2861804

Example of a six-activity model along with the input data and spreadsheet-calculated output data, from which the likelihood for various completion times and costs can be determined (a=best, b=most probable, c=worst, o=optimistic, m=most likely, p=pessimistic, te=expected time, σ=standard deviation σ^2=variance, Ce=expected cost)

Spreadsheet-based calculation

Central-limit theory thus allows the calculation of a range of a project's mean time and cost and associated probability through calculating the range of related standard deviations. By using a widely understood electronic spreadsheet approach, such as Microsoft Excel, rather than specialist scheduling and risk software packages needing skilled operators, a simplified method can considerably widen application.

Wider application will normally mean a more meaningful tool and hence improved project decision-making. Project data can be easily inputted into spreadsheet software, and a macro written to calculate automatically the output data from the stated input data.

Figure 1 shows an example of a six-activity model along with a table of input data and calculated output data. Based on the central-limit theory approach, the calculated likelihood of completing the work (event 40) by the end of, say, day 31 is predicted as 77%, by day 32 as 93% and by day 33 as 98·6%. The likelihood of the cost being below £42 608 is predicted as 84%, below £44 300 as 97·7% and below £45 992 as 99·8%.

The approach provides the decision-maker with a range of potential delivery dates and out-turn costs set against the degree of certainty. By selecting, say, 32 days as the target period the degree of uncertainty is about 7%, and by selecting a budget target of £44 000, the uncertainty on costs is about 3%.

The significance to project teams of the approach is that it embraces ranges of activity duration and cost and accordingly offers assessments of delivery and out-turn which can then be used to decide the targets for time and cost and what level of contingencies to use.

FOR FURTHER INFORMATION CONTACT

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