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Contingency for cost control in project management: a case study

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ABSTRACT

This paper provides a case study of the application of cost management techniques for project management of capital works within a major Australian electricity corporation. Historical data was collected from the corporation's archived files to establish the performance status of completed capital works projects. A survey of the corporation's project staff was also conducted to determine the current usage of cost management techniques and further explore the findings of the historical data search.

The research indicates a reluctance to utilise formal cost management procedures on minor projects, estimated to cost less than $1 million. The time constraints allocated to project management planning and the perceived cost to implement procedures were identified as contributing to the limited use of formal cost management on minor projects.

The paper concludes that increased risk of poor budget performance is inevitable if formal cost control is not applied to capital works projects, and recommends informal risk assessment and cost contingency measures to address this issue.

Keywords—project management, cost management, cost control, cost contingency, power supply industry

INTRODUCTION

The electricity industry in Australia is currently experiencing a period of rapid change and increased competition due to deregulation of the industry to allow contestability of supply to consumers. In this volatile environment greater emphasis is placed on cost management to ensure maximum return on investment for the limited funds available for capital works projects.

This paper describes a case study of a major Australian electricity corporation, codenamed E here for anonymity. Since E has entered the marketplace in search of external work it is also imperative that project profitability is actualised. Perceptions are that E performs very well in medium-to-large design and construction projects but has difficulty controlling costs on minor projects (less than $1 million). Large projects contain a substantial component of electrical plant purchased on period contracts and, therefore, costs are believed to be more certain. Minor projects tend to contain a high percentage of labour components and are perceived to be more difficult to control. The labour component is believed to be more variable and susceptible to a variety of influences, thus, cost overruns are more likely. Ideally, E would like to have greater certainty of individual project costs and therefore subsequent confidence in the capital works program budget.

The study involved:

- An extensive literature review of cost control techniques for project management;
- The examination of archived reconciliation reports, detailing performance measures from 155 completed capital works projects approved between January 1994 to September 1998; and
- A self-administered questionnaire survey of staff regularly involved in all phases of the project lifecycle, gathering information on their knowledge and practical application of accepted cost control procedures.

COST CONTINGENCY

Definition

One of the most controversial and least understood items in every estimate is 'contingency' (Clark and Lorenzoni, 1985, p116). Its calculation is a highly subjective part of cost estimating and is inconsistently interpreted and inadequately estimated (Moselhi, 1997, cited in Baccarini, 1998a, p7). It lacks a standard definition (Baccarini, 1998a) and '... is probably the most misunderstood, misinterpreted, and misapplied word in project execution' (Patrascu, 1988, p115).

The interpretation of definitions varies considerably from company to company and from estimator to estimator, with the net result of a broad range of application (Clark and Lorenzoni, 1985). Patrascu (1988, p115) concurs with Clark and Lorenzoni stating that 'contingency can and does mean different things to different people, and most are convinced that theirs is the right interpretation'. To management, contingency is money it hopes will not be expended but instead returned undepleted as profit at the end of the project. To engineers, contingency is a savings account that can be drawn on to cover the additional costs of underestimated or omitted project costs. To the construction department, contingency is a fund used to cover additional costs caused by longer schedules, construction problems and lower productivity. To the cost engineer, contingency is a fund that can be used to cover higher costs due to the lack of definition at the estimating stage, including underestimates of material, equipment, labour and indirect costs.

Attributes

The following key attributes of a cost contingency are (Baccarini, 1998a):

- It is a reserve of money;
- It is part of the cost estimating process;
- Its necessity and amount is associated with the existence of risk and uncertainty in projects. It caters for events within a defined project scope that are unknown, undefined, uncertain or unforeseeable; and
- It is a risk management tool. It provides a means to reduce the impact if retained risks eventuate and therefore is an 'antidote to risk' (Rosenau, 1992, cited in Baccarini, 1998a, p7). 'Whilst contingencies are a valid risk treatment strategy they should never be a substitute for proper risk analysis' (Martin and Heaulme, 1998, cited in Baccarini, 1998a, p7).

The inclusion of contingencies means that the cost estimate represents the total financial commitment for a project (Patrascu, 1988). This should avoid the need to appropriate additional funds and reduces the impact of overrunning the cost objective. The objective of contingency allocation is to ensure that the estimated project cost is realistic and sufficient to contain any cost incurred by risks and uncertainties (Mak, Wong and Picken, 1998).

Inclusions

Contingency in principle is intended to reduce the risk of overrun for a project executed under expected conditions. What elements should be included in contingency could in itself, however, become an item of contention (Patrascu, 1988). Baccarini (1998a) suggests the following main elements should be covered by contingencies.

Incomplete scope definition. Historically, as a project is more clearly defined, the estimate invariably increases (Clark and Lorenzoni, 1985). The amount of the contingency will depend on the stage in the development of the project.

Inaccuracy of estimating methods. Clark and Lorenzoni (1985) note that no estimating method or cost datum is perfect, and inadequacies historically result in low estimates. Woollett (1998) notes that with a large number of intangibles, the estimator often has to rely on his experience with similar projects to provide an 'educated guess' for these intangibles.

Identified risks. In this case there is considerable knowledge of the probabilities, and some form of qualitative risk assessment can be performed (Krosch, 1995). Examples of risks that may be associated with a probability factor include: plant availability; price escalation; heritage and environmental constraints; geotechnical anomalies; technological change; community expectations; and public utility delays (Krosch, 1995).

Unidentified risks. Chapman (1994, cited in Baccarini, 1998a) refers to unknown unknowns, a contingency reserve set up to allow for unidentified risks. For example, unforeseeable major events such as extreme weather conditions, earthquakes, riots, acts of war, new government regulations and economic collapse (AACE, 1992; Heinze, 1996; Moselhi, 1997, cited in Baccarini, 1998a).

Exclusions. Baccarini (1998a) suggests that, while contingencies include inadequacies of scope definition and should cover scope development, they should exclude scope changes.

Estimation

Contingency allowances are too often based on an historical percentage of the total cost (Woollett, 1998). This method is flawed because a total project contingency does not allow accountability for its expenditure. Furthermore, all parties assume that the contingency is their own and that, because it is for the unforeseen, it is without limit.

Numerous methods are available for the calculation and allocation of contingencies. Yeo (1990, p465) has proposed a two-tiered contingency allocation approach for project cost, consisting of an engineering allowance and a management contingency utilising a probabilistic framework. The engineering allowance is added to the estimator's base estimate to raise the probability of success to an even chance level. While the management contingency accounts for projects that are high risk because of poor project definition and because management expects a better-than-even chance of success (Yeo, 1990).

Ranasinghe (1994) utilised Yeo's general framework to develop a Contingency Allocation and Management (CALM) model based on the characteristics of individual bill item costs.

Patrascu (1988) agrees that developing contingencies will depend on the organisation, the type of business, the type of estimate and the phase of the project, and suggests four common methods for estimating contingency use:

- Overall percentage; added to the total cost estimate;
- Detailed percentage; applies a different percentage to each component of an estimate;
- Detailed percentage considering the probability of Occurrence; the probability that such contingency will be required applied to each component; and
- Risk analysis; uses a computerised simulation method such as MCS to break down the estimate into many components (Patrascu, 1988).

Woollett (1998) provides a simplistic assessment of the previous methods, suggesting that estimating contingency can be reasonably quantified by breaking out the elements which are not accurately known and assessing the probability of cost overrun for each of the elements.
An allowance is then made for the overrun and comparing it with similar projects can check the validity of the total contingency.

The contingency allowance will decrease as the project becomes more defined. For instance, Table 1 indicates how typical contingency allowances decrease as the project progresses (Woollett, 1998).

Phase	Contingency
Concept	± 20%
Planning and preliminary design	± 10%
Detailed design	± 8%
Construction	± 5%

Table 1: Typical Contingency Allowances
Source: Woollett (1998, p17)

Management

The attitude of project teams that contingency allowances are without limit is a major cause of cost overrun. The responsibilities for expenditure, monitoring and the magnitude and location of allowances in relation to the budget must be made perfectly clear to all parties concerned (Woollett, 1998).

The success of contingency management depends on:

- identifying project uncertainties and relating them to specific reserves;
- establishing procedures for the proper use of contingency reserves; and
- establishing an information system showing each responsible manager what contingency reserves apply to the work under their control, how they are being depleted, and how the trends appear for the remainder of the project.

Monitoring of trends will enable assessment of when it may be possible to transfer balances to other less successful areas or to general reserve (Avots, 1989, cited in Baccarini, 1998b, p13).

> 'Under no circumstances should contingency be treated as a slop fund', it is not an item to cover overruns (Clark and Lorenzoni, 1985, p122).

The individual allocation of contingency service management offers the advantages of showing precisely where contingency was used and indicating the balance of the available contingency (Patrascu, 1988). Consequently, unexpended funds can be transferred to a general contingency account (Baccarini, 1998b) or, more importantly, to other projects to accelerate the capital works program.

CASE STUDY: E'S CAPITAL WORKS

Introduction

E is a major electricity distribution corporation serving nearly one million customers. The organisation is responsible for the development, operation and maintenance of the local electricity transmission and distribution network. Planning requires the development, concept planning and project coordination of the capital works program to ensure the electricity network satisfies future load growth requirements. The majority of design and construction services are performed in house with the exception of large civil construction contracts and some minor subcontract works.

This section details a case study of E operations for delivery of the capital works program. In particular, consideration is given to cost management procedures for projects estimated to cost less than $1m.

Historical data

On completion of a capital works project a reconciliation report is prepared for senior management. The report describes project performance in terms of actual achievement compared to approved parameters, with respect to variance in approved scope, cost estimate or system requirement date. Included in the report are detailed reasons for any such variance and a recommendation of improvement opportunities for future projects.

Reconciliation reports were retrieved from the archived files of 145 capital works projects approved between January 1994 and September 1998. Reports were not available for projects approved prior to 1994, and projects approved after September 1998 had not been reconciled by the time the data was collected.

Survey questionnaire

The questionnaire avoided open-ended questions, using predominantly a quantitative, tick-a-box style format, with a section for qualitative comment on completion. The questions were designed to address the issues researched in the literature review and to evaluate staff perceptions of project management techniques and the extent of their use within E.

The following scales were used to develop and measure the survey data.

- Section A uses a 'nominal scale' to categorise individuals into mutually exclusive groups for frequency calculation of demographic information.
- Section B uses an 'ordinal scale' for ranking the importance that respondents attach to distinct characteristics of project performance.
- Section C uses an 'interval scale' (Likert scale) to measure the magnitude of individual perceptions of factors which influence project performance.
- Section D invited qualitative comment on any of the previous questions and, therefore, provides greater understanding of respondent's perceptions of project performance.

The questionnaire was distributed by e-mail to 80 E staff. The staff were selected because of their regular involvement in the cost management aspects of capital works project activities.

Analysis

Historical data

All of the 145 reports retrieved contained the total project costs for the approved estimate, actual expenditure and the calculated variance. Thirty-one percent of reports included an amount for contingency allocation.

Results were grouped into data series as follows:

- Project total estimate was rounded off up to the nearest increment and arranged in; increments of $50 000 up to $250 000, $250 000 up to $1m and $2.5m up to $10m.
- Date approved was rounded off to the next quarterly month following the actual date of approval and arranged in the months of March, June, September and December.

Error bars showing the standard deviation for projects cost variance (%) were added to data series to measure how widely values were dispersed from the average value (arithmetic mean).

Standard deviations and arithmetic means for variance (%) were tabulated for 'project total estimate' and 'date approved' in their respective data series. Scatter diagrams were generated from the tables and logarithmic trend lines added to emphasis the results.

Questionnaire survey

The survey achieved a final response of 67 questionnaires returned out of 80 issued or 84%. Invitations to participate in the survey were sent to staff from all phases of the project life cycle. In particular; eight from concept planning, 18 from detailed planning and preliminary design, 40 from detailed design, eight from construction and six from network operation. Since the surveyed population represents a large proportion of the participants involved in E project coordination activities across the various phases of project delivery, 84% is considered acceptable from which to draw conclusions.

Results

Historical data

Figure 1 displays the variance between the total project approved estimate, and the actual expenditure (expressed as a percentage of the approved estimate). This variance (%) is plotted against the date (quarterly) of project approval. Error bars show the standard deviation of each 'date approved' data series per quarter. There is a greater dispersal of variance (%) from September 1996 to June 1998, with standard deviation exceeding 20% for each quarter.

The standard deviations and arithmetic means for each data series were extracted from the graph and tabulated against the relevant 'date approved' as shown in Table 2. The number of entries per data series was also included. This was used to measure the number of projects approved in any given quarter and analyse any affect this might have on the standard deviation or arithmetic mean.

Date approved (quarterly)	Project #	Std. deviation total cost	Arithmetic mean total cost
Mar-94	2	5.21%	0%
Jun-94	2	3.43%	-11%
Sep-94	3	25.32%	-11%
Dec-94	2	14.95%	15%
Sep-95	6	17.84%	1%
Dec-95	5	14.91%	1%
Mar-96	4	42.41%	33%
Jun-96	5	18.49%	3%
Sep-96	17	30.75%	-3%
Dec-96	15	33.67%	11%
Mar-97	22	20.71%	-10%
Jun-97	19	28.03%	-13%
Sep-97	12	21.72%	-9%
Dec-97	12	28.00%	-3%
Mar-98	6	27.49%	-10%
Jun-98	12	25.99%	-18%
Sep-98	2	7.37%	-12%

Table 2: Number of Projects Approved per Quarter

Figure 2 displays the standard deviation of project total variance (%) plotted against the number of projects approved within the quarterly period that approval was obtained. The trend line displays a significant increase in standard deviation from 13% to 31%, as the number of projects approved each quarter increases.

Figure 3 displays the variance between the total project approved estimate and the actual expenditure (expressed as a percentage of the approved estimate). This variance (%) is plotted against the total estimate ($) approved for the project. Error bars show the standard deviation of each 'project total estimate' data series per increment ($). The greater dispersal of variance (%) is very obvious in projects estimated at less than $250 000 with standard deviation in excess of 20% for each increment.

The standard deviations and arithmetic means for each data series were extracted from the graph and tabulated against the relevant project total estimate as shown in Table 3.

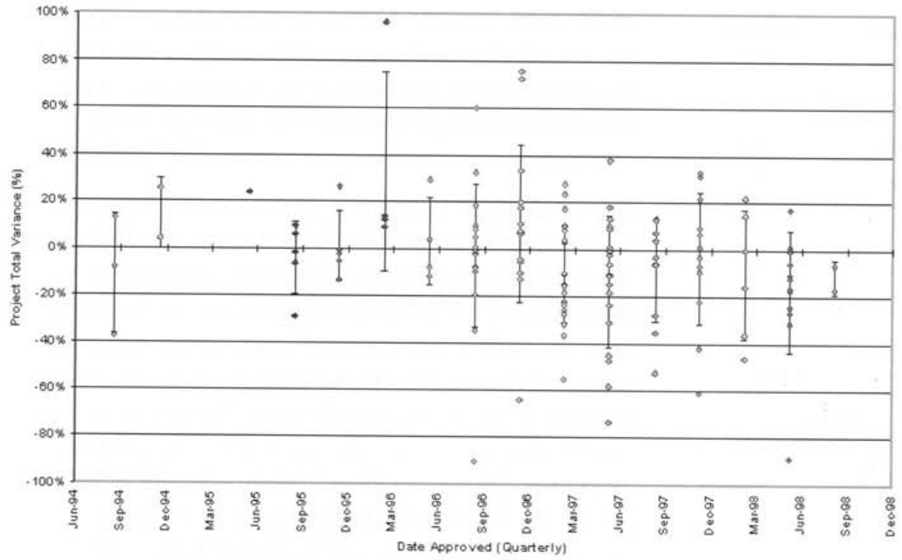

Figure 1: Project total variance per date approved

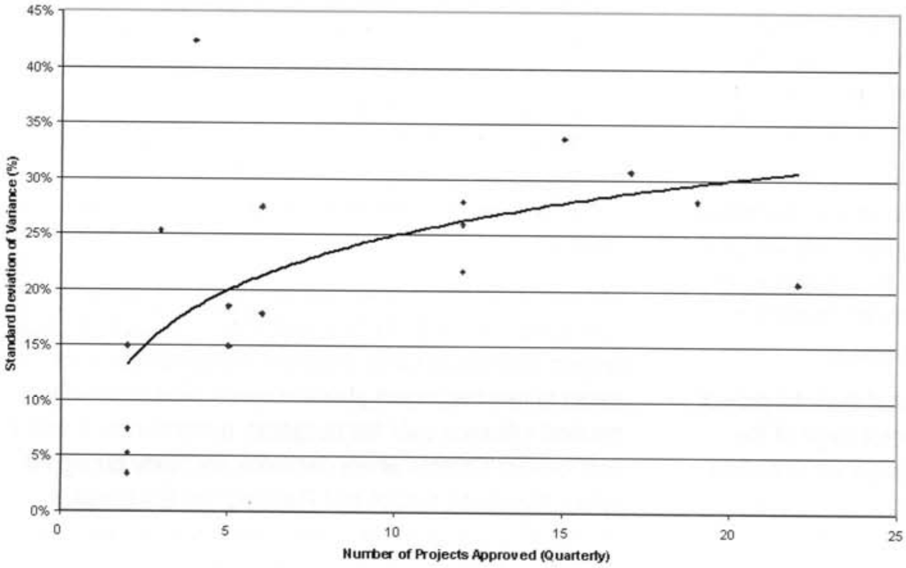

Figure 2: Standard deviation of variance per number of projects approved

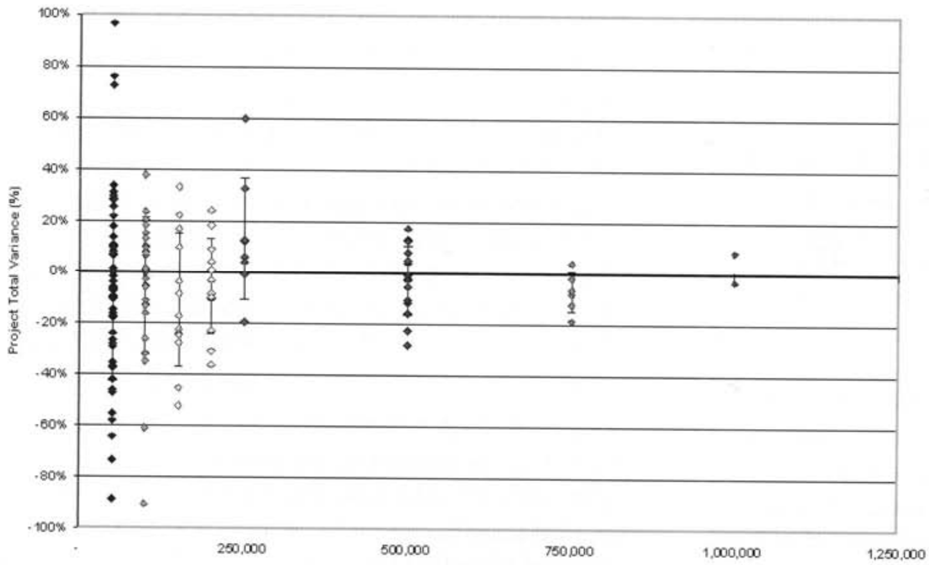

Figure 3: Project total variance per project total estimate

Project total estimate ($)	Project #	Standard deviation	Arithmetic mean
50 000	53	35.35%	-7%
100 000	29	26.74%	-6%
150 000	13	25.74%	-11%
200 000	12	18.36%	-5%
250 000	8	23.82%	13%
500 000	15	13.21%	-3%
750 000	6	7.77%	-7%
1 000 000	2	8.28%	3%
2 500 000	5	12.54%	7%
5 000 000	3	9.52%	-7%
7 500 000	2	5.63%	-5%

Table 3: Number of projects approved per $ increment

Figure 4 displays the standard deviation of project total variance (%) plotted against the project total estimate. The trend line shows a significant decrease in standard deviation from nearly 30% for $50 000 projects to 14% for $1m projects and down to 3% for $7.5m projects.

Figure 5 displays the variance between the total project approved estimate and the actual expenditure (expressed as a percentage of the approved estimate). This variance (%) is plotted against the contingency allocation (expressed as a percentage of the approved estimate). There is no appreciative trend evident in this relationship.

Figure 6 displays the plant component of the total project approved estimate (expressed as a percentage of the approved estimate). This (%) plant component is plotted against the total estimate ($) approved for the project. The project total variance (%) is included to show the relationship between plant component and project variance. The trend lines show the plant component increasing from 12% to 33% and the project total variance (%) decreasing from 12% to -10%, as the size of the project total estimate increases from $50 000 to $8m.

Questionnaire survey

The objective for Section A of the survey questionnaire was to establish the demographics for sorting data and classification of responses. Considerable experience in the electricity industry is evident from the responses, with 93% of respondents having worked in excess of 10 years in the industry and 66% having more than 20 years experience. Fifty-one percent have worked in their current position for less than five years. This could be attributed to industry changes in recent years including corporatisation of E and several departmental restructures within the organisation. Question 5 gauged the extent that relevant industry experience was applied to cost management criteria and found that 66% of respondents were required to prepare estimates at least once a month. Sixteen percent of respondents prepared estimates only once a year, the majority of whom were department managers who are not involved at project level estimating, however, they compile departmental budget forecasts from individual project estimates.

Section B sought to determine staff perceptions of project performance for comparison to known data collected during the historical cost research. Question 6 suggested to participants that the main project criteria of scope, timing, cost and performance are not all achievable in any given project and asked that they be rated in order from greatest importance (1) to least importance (4). Project Scope was of greatest importance to E projects with 37% of Rating 1 responses, followed by Project Timing with 39% of Rating 2 responses. Project Cost was perceived as the least important criteria with 30% of the Rating 4 responses.

The estimated cost size of a project is perceived by staff to have a significant influence on its budgetary performance. Fifty-one percent rated projects in excess of $2.5m as having the best chance of budgetary success, while 71% agreed that projects estimated to cost under $250 000 performed poorly. Performance was generally perceived to improve as the size of the project increased, this is consistent with the findings of the historical cost data research.

Question 8 sought to determine the effect that decision making had on the budgetary performance of a project with respect to timing of those decisions. Respondents were asked to rate the project phase in which decisions had the greatest influence over the budgetary performance. A total of 66% believe projects where decisions are made during the initial phases of Concept and Planning had the greatest chance of success. As the project progresses through the phases, decisions have diminishing influence over the project performance. Progressing down the scale; Planning received 39% of Rating 2, Design received 43% of Rating 3, while Construction received 51% of Rating 4 for decisions having the least influence over budget performance.

Respondents were asked to consider several common risk elements known to adversely affect the final project cost. Question 9 required these elements to be rated in order of greatest affect over the budget performance. 58% rated 1 for Incomplete Scope Definition having the greatest influence over budget performance. The second greatest risks are those that are Unidentified with 33% of Rating 2, while Inadequate Project Control received 46% of Rating 4 to indicate the least influence on budget performance.

Question 10 (Section C) sought to identify cost management factors from the literature review which may influence the performance of capital works projects within E. Respondents were first asked to rate on the use of formal cost control processes throughout the project lifecycle (Question 10a). This was a general overview statement to gain an appreciation of participant's knowledge and acceptance of

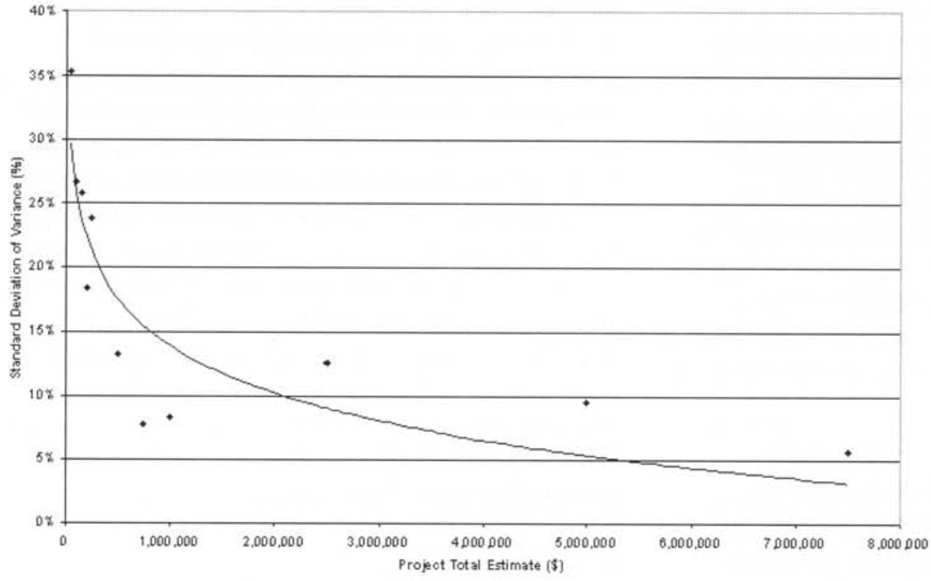

Figure 4: Standard deviation of variance per project total estimate

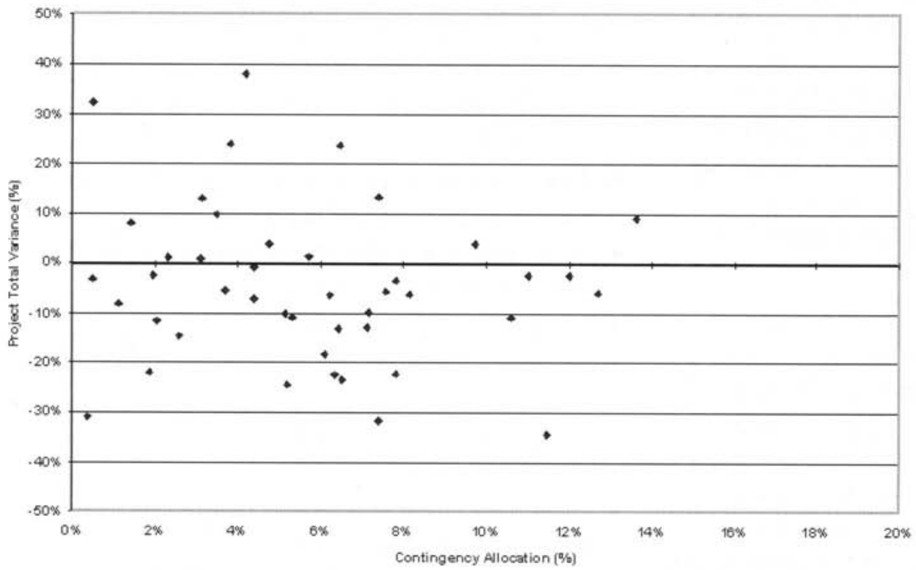

Figure 5: Project total variance per contingency allocation

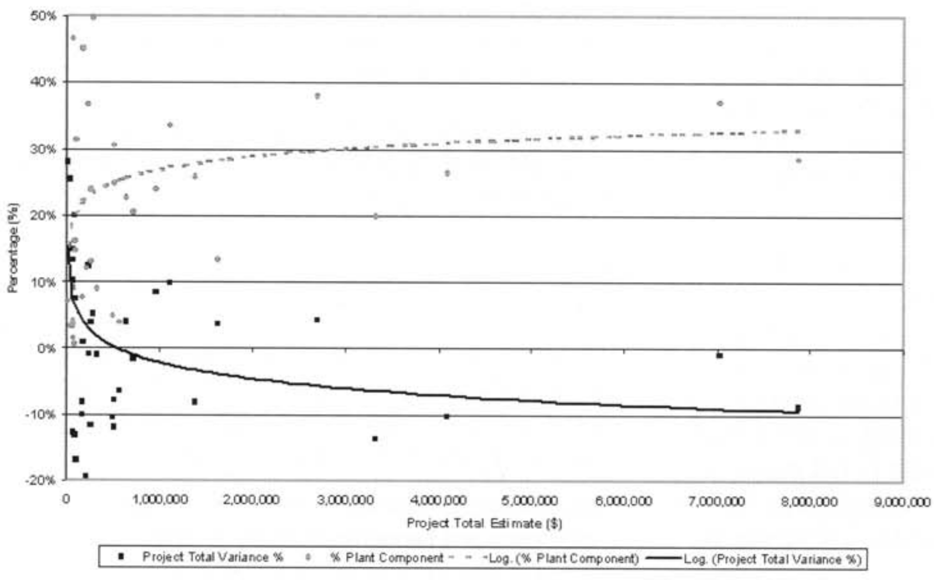

Figure 6: Project total variance per plant component

cost management techniques. The results were evenly divided about the median, providing no strong emphasis either for or against the use of cost management processes.

Statements 10b and 10c were used to gauge awareness and use of Value Management as a cost management tool. An obvious discrepancy was found between acceptance of the benefits of value management and practical application of the techniques. Forty-six percent of respondents agreed that value management allows cost reduction without compromising quality or function, however, 62% indicated that value management studies were not applied to projects.

Statements 10d, 10e, 10f and 10g addressed estimating requirements for cost management. In response to Statement 10d, to determine if budget estimates are produced from preliminary information, 57% agreed and 27% strongly agreed. However, Statement 10e revealed that estimates are not always updated when definitive information becomes available, as 43% agreed and only 12% strongly agreed with this statement. Respondents seemed generally satisfied with the level of estimating skills and training, with 42% agreeing with Statement 10f, although it is worth noting that 12% disagreed and 13% strongly disagreed. The significant contrast to satisfaction with the estimating techniques is evident in Statement 10g, where 36% disagree and 24% strongly disagree that sufficient time is allocated for preparation of detailed estimates and budget planning.

Respondents were asked to rate the use of budget performance indicators in Statements 10h and 10i, with no significant results evident. The results loosely follow a bell curve of normal distribution, with the rating emphasis on neither agree nor disagree. It seems unlikely that a cost baseline (S curve) is used to measure performance when only 3% of responses agree with the statement. The respondents were fairly evenly divided on the statement that personnel were kept informed of budget responsibilities and performance.

Monitoring of projects is closely related to the budgeting process and as such the results from Statements 10j and 10k are similar to budget performance. The responses range from 27% to 33% across the ratings of 'agree', 'neither agree nor disagree' and 'disagree' and are fairly evenly distributed about the median.

Statements 10l and 10m were used to evaluate the use of Risk Management, the resultant indication is that risk assessment studies are not generally used to identify potential areas of cost risk (only 13% agreed with the statement). However, there seems a strong commitment to rectify problems when they are identified, as 54% agreed with the statement in 10m as opposed to 13% disagreeing and only 9% strongly disagreeing. This indicates a reactive approach to risk containment rather than a pro-active risk management program.

Statements 10n, 10o and 10p analyse the knowledge and use of contingencies for cost control of capital works projects. The response to Statement 10n indicates that contingencies are not necessarily calculated by assessment of potential risk factors. Thirty-nine percent of respondents neither agreed nor disagreed with the statement, whereas 37% disagreed and 9% strongly disagreed that contingency plans were produced to overcome the eventuation of risks. However, 34% of respondents to Statement 10o agreed that contingencies were allocated to cover unforeseen costs, with only 13% disagreeing with the statement. Responsibility for contingency control was not established as 46% of responses rated neither agree nor disagree and 30% disagreed with Statement 10p that the project manager controlled the usage of contingencies.

Qualitative feedback

Section D invited additional comments on any of the survey questions detailed above, and a total of 23 responses (or 34%) was received. A selection of the more pertinent comments is included in this section. Seven of the comments received dealt with the main project management criteria of scope, time and cost and their interdependence. These included:

- 'If you scope the project in detail, project costs would be much better controlled and adhere to budget';
- 'Project work is basically 'urgent' and 'essential' to the functioning of electricity supply;
- The jobs must proceed regardless of cost;
- Completion of jobs 'on time' is generally critical to network security;
- 'Just in time' approach does not leave much opportunity for cost control';
- 'Projects are driven by a network requirement date, the quality and scope must ensure that the product performs as expected as soon as the plant is commissioned, therefore the cost suffers as a consequence'; and
- 'The best cost control is achieved when the scope is fully documented and estimates have been prepared by those required to do the work'.

Three respondents referred to the size of the project having an influence over the cost performance and the use of cost management techniques, including 'high value projects come out okay because major plant costs swamp the other costs and they are the most certain (particularly with long-term contracts)'.

One comment addressed project estimating, and suggested the use of standard modelling 'A simple standard method of estimating projects needs to be available using basic rates in such a way that there are standard models'.

Five respondents commented on monitoring and reporting of project costs and performance, however these were mainly directed at the new financial system recently introduced to E which is currently experiencing teething problems.

Comment on the allocation of contingencies was received from three respondents including:

- 'Contingencies should encompass cost provision for possible eventualities that are assessed as a reasonably high risk';
- 'Variations to scope should not be funded from contingency allowances but by separate justification and additional funds'; and
- 'Contingencies should be allocated to specific risk components and not treated as a general 'bucket' of additional funds to overcome poor performance'.

Discussion

Project management

Project management reconciliation reports, prepared on completion of a capital works project, recognise the importance of scope, time and cost and their interdependence. The reports provide details of the project performance including reasons for any variance to the project criteria plus recommendations for improvement opportunities. Ideally, E would like projects positioned on the optimum balance point of scope, cost and time. However, all three project criteria are rarely achievable in any given project, Lewis (1995) suggests 'pick two' and the third must be allowed to vary. The study supports the view that all three criteria are not always achievable and that project cost is where the greatest variance is most likely to occur.

Scope of E projects is generally governed by network requirements to ensure integrity of the transmission and distribution systems in accordance with statutory regulations and customer expectations. A design brief is usually produced for each project based on a standard pro forma to ensure consistency of presentation and prevent omissions.

The survey rated project scope as the criteria of greatest importance to capital works projects. According to Duncan (1996) proper scope definition is critical to project success.

Timing of E projects is generally dependent on a network requirement date, usually April or October, to cater for anticipated peak loads in winter or summer respectively. A number of standard Gantt charts for various project types are to be applied to individual projects. The templates are adjusted to suit the work breakdown structure detailed in the design brief and the network requirement date is applied to determine the project baseline.

The survey rated Timing as the criteria of second greatest importance behind scope. Clark and Lorenzoni (1985, p139) discussed the importance of schedule control in describing the construction of a new process plant: 'The plant should be completed and on stream at the specified time so that the owner can meet product delivery commitments to his customers'. The critical timing requirement of E projects was acknowledged by several comments from the survey. Cost variation to the approved estimate was the most prominent criteria detailed in reconciliation reports. Indeed, Patrascu (1988) suggests that cost seems to be the most difficult of the three project criteria to control, as the schedule and scope are prone to revision throughout the life of the project. Estimates rely on professional experience and are generally based on data from previous projects, applied to the WBS detailed in the project design brief.

The survey rated Cost as the criteria of least importance to E capital works projects. Survey comments referred to other project elements that impacted on project cost, supporting the theory that cost control alone is not achievable due to its interdependence on the other criteria.

Cost management

The 'bottom line' cost performance of E capital works projects approved between January 1994 and September 1998 seems very respectable at first glance, with an overall total estimated cost of $50.5m and total actual expenditure of $49.0m which equates to a relatively low variance of -$1.5m or -3%. The total cost of each component looks equally impressive with variances at between -1% and 4% overall. The exception is concept planning at 27%, which is not unexpected during the early phases of a project. However, the wide dispersal of variance (%) for individual projects (Figure 2), indicates that project costs are not necessarily under control.

When discussing cost variance to budget the natural tendency is to assume a cost overrun. The case study research revealed a fairly even distribution of projects subject to underspending as well as over commitment. In a large organisation with numerous projects active at any given time, it is no more desirable to underspend on projects than it is to overrun the budget. The failure to accurately estimate cash flow can leave funds idle that would give better service elsewhere, either on additional projects or investment opportunities.

The chance of successful budget performance seems to be dependent on the size of the estimated total cost of a project. The survey rated projects estimated to cost under $250 000 as having the worst budget performance. Historical data supports this perception showing a trend towards increases in standard deviation of variance (%) as the project size decreases, in particular below $250 000 (Figure 5).

The plant component is believed to be a stabilising influence on the performance of large projects. Figure 6 shows the relationship between the project total variance decreasing as the plant component percentage of the project total estimate increases. Minor projects tend to not have a substantial component of plant included and the labour component is greater for refurbishment projects.

Cost control is achieved by comparing where one is with where one is supposed to be, then taking corrective action to resolve any discrepancies that exist (Lewis, 1995). The survey revealed that formal cost control processes were not necessarily used throughout the project lifecycle. E's policy requires the implementation of formal cost management procedures only for projects in excess of $1m. The time and cost required to apply formal cost management to minor projects has not previously been justified.

Survey results from Question 10 reflect much the same trend towards minimal usage of cost management techniques. The benefit of cost management techniques such as value management, budgeting, monitoring and reporting and risk management were acknowledged by the survey. However, the regular application of these techniques to E projects was not evident. The majority of comments referred to the lack of time allocated to perform formal cost management procedures as the greatest influence.

The positive application of cost estimating techniques, identified in the survey, is negated by insufficient time allocated for preparation of detailed estimates and budget planning. The interdependence on time can affect the accuracy of cost estimating, similar to the effect on actual cost to complete the work. The research suggests that the chance of successful budget performance is dependent on the number of projects approved in that quarter. Historical data shows a trend towards an increase in standard deviation of variance (%) as the number of projects approved per quarter increases (Figure 3).

Cost contingency

The total cost contingency allocated to E capital works projects during the period researched from January 1994 to September 1998 was $735 217 or 1% of the overall project total estimate. Individual contingency allocations varied from 0% to 14% of the project total estimate.

Clark and Lorenzoni (1985) observed that 'contingency' is one of the most controversial and least understood items in every estimate. The historical data showed no apparent trend in the relationship between contingency and project total variance suggesting a systematic approach to contingency allocation was used. Neither was there any indication that the application of contingencies was effective. To add to this uncertainty, the survey disagreed with the statement, that contingency plans were produced for the eventuation of identified risks.

The survey suggests that cost contingencies were allocated to cover unforeseen elements in the majority of projects. This is in contrast to the historical data, which shows only 46 projects (or 32%) were allocated an amount for contingency. This could indicate that individual departments are adding a contingency sum to their own component estimates, which might explain the unusually high number of projects regularly completed under budget. According to Patrascu (1988), contingency is a separate fund in the estimate and should not be included under each cost item.

Without a contingency plan it is difficult to assess how cost contingencies were allocated or controlled. Reconciliation reports provided minimal information on the reasons for contingency allocation, it seemed to be distributed on an 'as needs' basis to cover any shortfall in the project estimate. The survey acknowledged that the project manager did not control cost contingency usage. Woollett (1998) warns that a contingency based on a percentage of the total project cost does not allow accountability for its expenditure, all parties assume that the contingency is their own and that, because it is unforeseen, it is without limit.

CONCLUSIONS

The historical data and survey results substantiated the problem statement given as 'E capital works budget performance is generally poor on projects estimated to cost less than $1m total'.

The common reason for non-compliance with cost management procedures was found to be the lack of time allocated or available for application of the techniques. E capital works projects are often required urgently. The total lifecycle of minor projects can often be completed in a relatively short time and it may not be feasible to apply the full suite of project management techniques. Indeed, E's policy recognises the time restriction and the cost to implement procedures, by not enforcing formal cost management of projects under $1m total.

Risk and uncertainty are inherent to all pre-construction and construction activities. In the absence of formal cost management there is increased uncertainty and likelihood of occurrence of risk affecting the cost of the project. The application of formal risk management has, however, been identified in the case study as unpractical for minor projects due to time constraints.

Contingency is a risk management tool that can be used to reduce the impact on project cost if risks eventuate. Other methods of risk reduction include contractual transfer of risk to other parties and implementation of formal project procedures. Since the majority of project work is performed 'in house' and the research shows that time constraints restrict the use of formal project procedures, these methods are not considered feasible.

An informal approach to risk management could be used for generic application to E projects. The key stakeholder's experience could be used to develop standard contingency plans for each basic project type by assessing the potential risks inherent to each type. Krosch (1995) suggests measurement is best done by examining historical data from completed projects and making adjustments to reflect any changes in the nature of the particular project. The greatest challenge would be the short-term commitment of significant resources required for collation of historical data and detailed analysis to complete the initial risk assessment and develop contingency plans.

The objective of contingency allocation is to ensure that the estimated project cost is realistic and sufficient to contain any cost incurred by risks and uncertainties (Mak, Wong and Picken, 1998). The development of standard contingency plans should include cost contingencies quantified and allocated to each element of identified risk as an engineering allowance. Contingency should not be based on a percentage of the total cost and used to cover inadequacies in estimating methods.

A series of contingency plans based on historical data could be developed as templates to be applied to various project types. Templates may be as simplistic as an allowance for each phase of the project as advocated by Woollett (1998) and illustrated in Table1, and should be reviewed and updated as definitive information becomes available.

Allocating contingency to specific risk elements allows greater control over its usage, thus avoiding the contingency being treated as a 'slop fund'. There is a natural tendency to draw down on a 'bucket' account with the potential to exhaust the contingency fund before the project is complete. Contingency is a separate fund and should not be included in cost estimates for individual components, otherwise the cost to complete the work will expand to fill the budget. To avoid misuse of contingency funds, stakeholders need to be accountable and educated on the benefits of proper contingency management.

The contingency allowance should decrease as the project becomes more defined and known risks subside. The individual allocation of allowances offers the advantages of showing precisely where contingencies were used and indicates the balance of the available contingency. This would enable unexpended funds to be transferred to other projects or to enhance the capital works program.

Greater emphasis on effective cost contingency management to address increased risk in minor projects, would enable those projects to proceed with a greater degree of certainty of the final cost and confidence in the likelihood of successful completion.

The study focused on contingency for cost control in project management to glean information from the literature review and gather data from the survey. During the process, additional topics associated with project cost management were identified for further study. The topics include scope definition, monitoring and reporting and presentation of cost reports.

Scope definition is believed to have a major influence on cost control. Comments received with the survey included reference to better cost control being achieved when the project scope is fully documented in detail and not subjected to change. The literature review supported these perceptions with Duncan's (1996) view that poor scope definition causes final project costs to be higher because of changes that disrupt project rhythm, cause rework, increase project time and lower productivity and morale.

Monitoring and reporting is generally assumed to be for the purpose of informing management of the current status of the project. However, several authors recognised monthly reporting as an important cost management tool. In particular, Clark and Lorenzoni (1985) advocate cost forecast reporting for advising personnel of the cost impact of decisions and actions taken during the previous month. Common complaints from the survey referred to poor feedback from previous projects, little feedback received on financial performance and no information received on work group performance.

Presentation of cost reports was identified as beneficial to project cost control if presented in an effective format. It is important to distinguish between cost control and cost accounting. Humphreys and English (1993) describe cost accounting as the historical reporting of actual costs of a project to date, whereas cost control is used to predict the final outcome of a project. Control of project costs depends on measurement of progress against a baseline.

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REFERENCES

Baccarini, D. (1998a). Project Risk Management—Cost Contingency, *Australian Project Manager*, 18, 7–8.

Baccarini, D. (1998b). *Cost Contingency—A Review*, Australian Institute of Quantity Surveyors, Refereed Journal, 2, 8–15.

Clark, F.D. and Lorenzoni, A.B. (1985). *Applied Cost Engineering*, M. Dekker, New York.

Duncan, W.R. (ed.) (1996). *A Guide to the Project Management Body of Knowledge*, PMI Standards Committee, Project Management Institute, Upper Darby.

Humphreys, K.K. and English, L.M. (1993). *Project and Cost Engineers' Handbook*, M.Dekker, New York, AACE International, Morgantown.

Krosch, A. (ed.) (1995). *Total Project Cost Control Guidelines*, Queensland Dept.. of Transport, Infrastructure Development Division, Brisbane.

Lewis, J.P. (1995). *Project Planning, Scheduling and Control: A Hands-on Guide to Bringing Projects In On Time and On Budget,* Irwin, Chicago.

Mak, S., Wong, J. and Picken, D. (1998). The effect on contingency allowances of using risk analysis in capital cost estimating: a Hong Kong case study, *Construction Management and Economics*, 16, 615–619.

Patrascu, A. (1988). *Construction Cost Engineering Handbook*, M.Dekker, New York.

Ranasinghe, M. (1994). Contingency allocation and management for building projects, *Construction Management and Economics*,12, 233–243.

Woollett, J. (ed.) (1998). *Project Cost and Risk Management*, Queensland University of Technology, Brisbane.

Yeo, K.T. (1990) Risks, Classification of Estimates, and Contingency Management, *Journal of Management in Engineering*, ASCE, 6, 458–470.