

THE RELIABILITY OF CAPITAL COST ESTIMATES

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Wellington**

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ABSTRACT

This study was undertaken to update the National Roads Board "Economic Appraisal Manual" (1986), now superseded by Transit New Zealand's "Project Evaluation Manual" (1991). The updating includes a review of sensitivity analysis procedures carried out in 1991.

Transit New Zealand is seeking to establish appropriate guidelines for the variation of estimated construction cost values to be used in sensitivity testing within project evaluation. To do this, a survey of Works Consultancy Services personnel with experience in roading work for Transit New Zealand was made to seek their opinion of appropriate ranges above and below estimated expected values by which final construction costs could vary.

Ranges of values were requested for three stages of project cost estimates:

1. Feasibility
2. Preliminary investigation/report
3. Final design

Each of these was subdivided into two project types: well-known and less well-known projects.

Fourteen responses were received to the survey questionnaire and results are presented. From these results, projects were placed in three categories: well-known, no clear preference, and less well-known. They were then re-analysed, taking account of the range of values given by respondents for each specific project type. The list of projects falling into each category is also presented.

Recommended variations for capital cost for use in project sensitivity analysis are as follows:

Project Type	Project Stage	Recommended Variation	
		Above (+ %)	Below (- %)
Well-known	1. Feasibility	25	20
	2. Prelim. Invest./Report	15	15
	3. Final Design	10	10
No clear preference	1. Feasibility	30	20
	2. Prelim. Invest./Report	20	15
	3. Final Design	10	10
Less well-known	1. Feasibility	35	25
	2. Prelim. Invest./Report	25	20
	3. Final Design	15	15

1. INTRODUCTION

The work reported in this study was undertaken to update the Economic Appraisal Manual (National Roads Board 1986), now superseded by the Project Evaluation Manual (Transit New Zealand 1991), used for economic evaluation of roading projects. The updating includes a review of sensitivity analysis procedures. These procedures require estimated capital costs to be given a range of values within the economic evaluation process to take account of possible variations between estimated and final costs.

The objective of this project has been to establish appropriate guidelines for sensitivity testing by surveying and establishing the opinions of practitioners with experience in the design and construction of roading works.

2. PROJECT PROCEDURE

Selected Works Consultancy Services staff in 12 branch offices were surveyed by a questionnaire which sought opinions of the range above and below estimated expected values by which final construction costs could vary.

In general, two persons in each branch received the questionnaire, a design manager and an operations manager, both with experience in roading work for Transit New Zealand. In most cases the two persons combined to give a single response to the questionnaire, as the design manager was familiar with early stages of estimating for projects and the operations engineer was familiar with contract costs.

The range requested was for three stages of estimated expected project costs:

1. Feasibility
2. Preliminary investigation and report
3. Final design

A further subdivision of each of these into two project categories - well-known and less well-known projects - was also requested.

Respondents to the questionnaire were supplied with a list of project types (Table 1) and were asked to group these into the categories of well-known and less well-known projects.

When all results had been summarised, respondents were informed of the summary and given the opportunity to revise their opinions. In fact only one person made changes, and they lowered a number of their original values.

Table 1. Project types listed in questionnaire.

1.	Structural Bridge Repairs
2.	Resealing
3.	Second Coat Chipseals
4.	Shape Corrections (excluding asphaltic concrete overlays)
5.	Seal Widening
6.	Bridging
7.	Bridge Approaches
8.	Reconstruction
9.	Extension of Seals
10.	Pavement Marking
11.	Safety Improvement Projects over \$200,000
12.	Safety Projects under \$200,000; i.e. minor RAIT works, etc.
13.	Asphaltic Concrete Overlay
14.	First Coat Seals
15.	Motorway Construction
16.	General Highway Construction
17.	Tunnel Construction
18.	Culverts

3. PROJECT METHOD

Opinion of "above" variation (e.g. +30%) and "below" variation (e.g. - 20%) around the estimated expected values was sought. These variations describe the range within which the final project cost is expected to lie. It is not, however, an absolute range. Instead it should be regarded as an appropriate range which covers most cases and allows a sensible approach to be taken to sensitivity-testing and decision-making. This requirement was made known to those taking part in the survey.

Respondents were also asked to omit the effects of changes in job scope and price escalation on final costs. These are effects for which specific provision should be made in the economic evaluation. They were also asked to assume the situation to be one in which the estimator was relatively experienced in the type of work being undertaken (within the limits of some projects falling into the "less well-known" category). The validity of this assumption and its impact on estimate variability is a matter to be examined by Transit New Zealand at the vetting stage and not for inclusion in the sensitivity analysis.

4. RESULTS

The results from 14 responses are set out in Tables 2 to 4. Tables 2 and 3 give ranges by which final construction costs could vary from estimated value.

Project Stage	Variation From Expected Value							
	Above (+ %)				Below (- %)			
	Mean	Std Dev.	Most Freq.	Range	Mean	Std Dev.	Most Freq.	Range
1. Feasibility	25	7	30	10-35	17	4	20	10-20
2. Prelim.invest/ report	15	4	15	10-20	13	3	10	10-20
3. Final design	9	2	10	5-10	8	3	5/10	5-15

Table 2. Variation in capital cost estimates for well-known projects.

Project Stage	Variation From Expected Value							
	Above (+ %)				Below (- %)			
	Mean	Std Dev.	Most Freq.	Range	Mean	Std Dev.	Most Freq.	Range
1. Feasibility	38	9	40/50	25-50	25	10	20	5-50
2. Prelim.invest/ report	25	6	20/30	15-35	17	6	20	5-30
3. Final design	15	6	15	5-30	12	6	5/10	5-20

Table 3. Variation in capital cost estimates for less well-known projects.

Table 4 sets out the number of times the projects of Table 1 were categorised by respondents as falling into the well-known group or the less well-known group. The right-hand column gives a suggested categorisation into well-known (W), less well-known (L), or no clear preference (N).

Table 4. Categorisation of projects.

Project Type	Number of times grouped into each category		Suggested Category*
	Well-known	Less well-known	
1. Structural Bridge Repairs	1	11	L
2. Resealing	12	0	W
3. Second Coat Chipseals	11	1	W
4. Shape Corrections (excl. asphaltic concrete overlays)	8	4	W
5. Seal Widening	9	2	W
6. Bridging	7	5	N
7. Bridge Approaches	5	7	N
8. Reconstruction	3	8	L
9. Extension of Seals	5	5	N
10. Pavement Marking	11	1	W
11. Safety Improvement Projects over \$200,000	4	8	L
12. Safety Projects under \$200,000	4	8	L
13. Asphaltic Concrete Overlay	7	1	W
14. First Coat Seals	12	0	W
15. Motorway Construction	3	5	L
16. General Highway Construction	5	5	N
17. Tunnel Construction	1	6	L
18. Culverts	6	2	W

* L Less well-known
W Well-known
N No clear preference

5. OUTCOME OF RESULTS

The following variations are possible for capital costs that may be used within project sensitivity analysis, based on the results of Tables 2 and 3.

Project Type	Project Stage	Recommended Variation	
		Above (+ %)	Below (– %)
Well-known	1. Feasibility	25	20
	2. Prelim.invest/report	15	10
	3. Final Design	10	5
Less well-known	1. Feasibility	40	25
	2. Prelim.invest/report	25	15
	3. Final Design	15	10

Table 5. Possible variations for capital cost estimates.

6. DISCUSSION AND FURTHER ANALYSIS

A number of respondents noted that contract prices depend on economic conditions. At the time of the survey, conditions were causing prices to fall unexpectedly as constructors fought to remain in business. Consequently construction costs were much lower than estimates. This can be viewed as a disparity between the data held by estimators and current conditions, and should be a short-term effect only.

Table 4 shows that a number of project types are regarded as well-known by some and less well-known by others. These are grouped in the category "no clear preference". It may therefore be advisable to have three categories when considering sensitivity analysis and further analysis was undertaken on this basis.

For this analysis, the projects have been grouped into the three categories given in Table 6. Average values for all projects within each group were then evaluated (taking account of the fact that some projects are given high values by some and low values by others). The results are set out in Table 7, 8 and 9.

Table 6. Final categorisation of projects.

Well-Known Projects

Resealing

Second Coat Chipseals

Shape Corrections (excl. asphaltic concrete overlays)

Seal Widening

Pavement Marking

Asphaltic Concrete Overlay

First Coat Seals

Culverts

No Clear Preference

Bridging

Bridge Approaches

Extension of Seals

General Highway Construction

Less Well-Known

Structural Bridge Repairs

Reconstruction

Safety Improvement Projects

Motorway Construction

Tunnel Construction

Project Stage	Variation From Expected Value							
	Above (+ %)				Below (- %)			
	Mean	Std Dev.	Most Freq.	Range	Mean	Std Dev.	Most Freq.	Range
1. Feasibility	24.7	9.9	30	10-50	18.6	8.7	20	10-50
2. Prelim.invest/ report	16.0	6.8	10	5-35	13.1	6.8	10	5-40
3. Final design	10.7	5.3	10	2-35	9.5	6.1	10	2-33

Table 7. Variation in capital cost estimates for well-known projects.

Project Stage	Variation From Expected Value							
	Above (+ %)				Below (- %)			
	Mean	Std Dev.	Most Freq.	Range	Mean	Std Dev.	Most Freq.	Range
1. Feasibility	30.8	10.4	30	10-50	19.1	8.1	20	5-30
2. Prelim.invest/ report	20.3	7.1	20	10-35	15.0	6.5	10	5-40
3. Final design	11.9	4.9	10	5-25	10.8	5.7	10	5-33

Table 8. Variation in capital cost estimates for projects with no clear preference.

Project Stage	Variation From Expected Value							
	Above (+ %)				Below (- %)			
	Mean	Std Dev.	Most Freq.	Range	Mean	Std Dev.	Most Freq.	Range
1. Feasibility	34.5	8.4	30	25-50	23.1	8.1	20	5-50
2. Prelim.invest/ report	23.0	6.7	20	15-35	17.1	7.4	20	5-40
3. Final design	13.0	4.7	10	5-25	12.1	6.9	5	5-33

Table 9. Variation in capital cost estimates for less well-known projects.

7. RECOMMENDED VARIATIONS FOR CAPITAL COST ESTIMATES

Table 10 sets out recommended variations for capital cost for use within project sensitivity analysis, based on the results of Tables 7 to 9.

Project Type	Project Stage	Recommended Variation	
		Above (+ %)	Below (– %)
Well-known	1. Feasibility	25	20
	2. Prelim.invest/report	15	15
	3. Final Design	10	10
No clear preference	1. Feasibility	30	20
	2. Prelim.Invest/report	20	15
	3. Final Design	10	10
Less well-known	1. Feasibility	35	25
	2. Prelim.invest/report	25	20
	3. Final Design	15	15

Table 10. Recommended variations for capital costs, to use in project sensitivity analysis.

8. REFERENCES

National Roads Board 1986. *Economic appraisal manual*. National Roads Board, New Zealand.

Transit New Zealand. 1991. *Project evaluation manual*. Transit New Zealand, Wellington, New Zealand.