TOTAL PROGRAMME ANALYSIS FOR THE JUSTIFICATION AND BUDGETING OF CAPITAL INVESTMENT IN TRANSPORT

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ABSTRACT: *The paper describes the development, methodology and application of a process of collating, co-ordinating and justifying transport capital investment recently introduced in Western Australia.*

The Total Programme Approach (TPA) focuses attention on the expected accounting and financial performance of the works programme as an entity. Using normal budgeting data and the results of project evaluations, supplied by each operating authority, TPA standardises the presentation of programmes and generates five criteria by which each programme may be judged. TPA also permits the comparison of independent programmes competing for scarce funds and formalises the development of a strategy for project approval within a programme subjected to capital shortage.

A brief description is given of the EDP program used and several practical examples of TPA in action are given. Finally, plans for the further development and intensified application of TPA are discussed.

Paper for Presentation in
Session 7,
also background for Session 11

JUSTIFICATION OF TRANSPORT CAPITAL INVESTMENT IN W.A.

In Western Australia the Director General of Transport (DGT) is statutorily charged with the duty of:

> .... collating and co-ordinating capital works programmes for public transport services and justifying such expenditure thereon as is, in his opinion, warranted and recommending times for the commencement and completion of those programmes (Western Australia, 1966).

The publicly owned operators of transport services in W.A. which are currently embraced by this duty are:

- Western Australian Government Railways (Westrail)
- Metropolitan (Perth) Passenger Transport Trust (MTT)
- W.A. Coastal Shipping Commission (Stateships)
- Esperance, Albany, Bunbury, Fremantle, Geraldton, and Port Hedland Port Authorities
- Harbour and Light Department.

To justify something means to demonstrate its rightness. The judgment of the rightness of an investment is normally based upon a comparison of all the benefits which it produces with all of the costs of providing them. It is the decision as to what to include as benefits and what to include as costs that often makes the judgment difficult. In the Private Sector the costs and benefits are relatively easily identified as cash flows or revenue streams. However, in the Public Sector, Governments sometimes choose to include in their judgment benefits and costs which are external to the authority proposing the investment and may even lie outside the normal market mechanisms. Thus, in estimating final justification, the political process brings to account financial, economic and non-economic factors.

Since the accountability for transport operation rests with the operators, the initiative as to what investments are actually proposed in the first place quite rightly lies with them. The DGT's primary role is therefore to formulate an opinion of the justification for the investment programmes proposed by the operators and to recommend to the Minister the portions of the programmes which the operators have quantitatively justified in an acceptable manner. Much potential duplication of effort may be avoided through the justification process serving the needs of operating managements to review performance and planning and those of the DGT.

In executing the investment justification duty the DGT has, with the assistance of the operating authorities, developed the annual capital budgeting cycle summarised in Table 1 below.

TABLE 1
ANNUAL CAPITAL BUDGETING CYCLE

Month	Activity
December	Draft preliminary proposed capital works programme supplied to DGT by operating authorities.
January February	Perusal of preliminary programmes by DGT and liaison with operating authorities.
March April	Preliminary proposed capital works programmes and 5-year rolling programme to Minister for Transport, Treasury, DGT. TPA analysis by DGT. Preliminary programme DGT report to Minister, authorities, Treasury.
May June	Liaison with authorities on evaluation methodology, justification, timing, priorities.
July August	Final proposed programmes and revised 5-year rolling programme supplied to Minister, Treasury, DGT. TPA analysis by DGT. Supplementary DGT report to Minister, authorities, Treasury.
September	Programmes tailored to available funds Cabinet approval - State Budget.

Two distinct, but related, approaches have been used in the formulation of the DGT opinion of justification - they are:

- Project by Project Analysis (PPA) - where the justification for each project per se, is established by the application of well known and appropriate capital investment evaluation techniques and through the consideration of all practicable alternatives.

- Total Programme Analysis (TPA) - where the justification for the total programme proposed by an authority is established as an entity - even though a particular programme may contain some well justified and some not justified projects by a PPA.

DEVELOPMENT OF TPA

The following two significant findings resulted from a financial and accounting study (Bettison,1976) of the W.A. transport operating authorities, at a time when only PPA was used:

- it was not possible (at that stage) to identify with any precision, the financial impact of the operating authority programmes,
- a large portion of the proposed programmes had not been quantitatively evaluated.

These findings, plus ...

- a lack of DGT resources to apply PPA to the increasing complexity and number of projects involved in recent programmes,
- a general need for more concise, yet comprehensive, analytical guidance on the appropriate dollar size of programmes,
- a wish to become less involved in operational considerations and to further develop our strategic and policy advice capacity,
- an attempt to demonstrate the DGT's sincerity in minimising interference in what may be regarded as "management prerogatives",
- an acknowledgement that some of the operating authorities had equipped themselves with modern planning and capital investment appraisal skills with which they could screen individual projects before including them in an annual capital programme,

... motivated the development and manual use, in 1977, of TPA to appraise Westrail's preliminary proposed 1977-8 programme (Bettison et al., 1977).

The results of this new approach to justification were well received by the Minister for Transport, Westrail, and Treasury and the 1978-9 budget round saw TPA developed further and applied to MTT as well as Westrail (Bettison et al., 1978).

TPA IN DETAIL

The Five Criteria

Each of the following five criteria is calculated for the capital expenditure proposed in the budget year.

NAFET: is an estimate of the average financial effect which the budget year's proposed Capital Works programme will have on future annual Profit and Loss Statements. NAFET is distinctly orientated to the peculiarities of existing accounting practices of the operating authorities and which often cause their annual financial results to be substantially overstated.

NAFET does not take account of project to project variations in the timing of net benefits and capital expenditures but does include cost escalations expected in future years.

$$\text{NAFET} = \frac{\sum_{i}^{m}\left\{\sum_{i}^{n} b_{ej} - \left(\sum_{i}^{n} d_j + \sum_{i}^{n} i_j\right)\right\}}{n}$$

An acceptable value of NAFET is one equal to, or greater than, zero.

The terms used above are:

m = number of projects in budget year's programme, or programme category.

n = 16 years - being the budget year plus 15 years beyond.

b_{ej} = annual net benefits, after deducting operating and maintenance expenses etc. (but NOT capital expenditure) which are estimated to be generated by the budget year's proposed capital expenditure - in escalated prices.

d_j = annual depreciation expense which will be generated by the proposed capital expenditure on the project in the budget year. d_j is calculated from historical cost to be consistent with accounting practice.

i_j = annual interest charges which will accrue on funds to be borrowed in the finance year to support the proposed programme.

One objective of TPA is to distinguish the performance of the budget year's programme from that generated by capital expenditure in future years. The identification of the appropriate value of b_{ej} for expenditure which will complete a self-contained benefit generating element[1] of a larger project which is expected to span several years (i.e. a divisible larger project) is a relatively simple exercise. Either specific annual values of b_{ej} are estimated by the authority concerned or they are proportioned by the ratio of the budget year capital expenditure to the total capital expenditure. At this stage the proportioning treatment given to divisible projects is also arbitrarily applied to indivisible projects (i.e. those whose capital expenditure spans several years and are in practice incapable of generating any benefits until completed). Other alternatives considered have the undesirable effects of biasing programme performance in favour of short or long projects and/or adding unnecessary complexity.

Both d_j and i_j are generated for all proposed investments, regardless of whether b_{ej} has been quantified. This is because the "penalties" of depreciation and interest will be incurred by the accounting reports regardless of whether any net benefits have been identified. The capital expenditure upon which i_j and d_j are historically based is escalated to December of the budget year and is computed by an expression tailored to the authority concerned (Bettison & Wildermuth, 1978). In contrast, b_{ej} is escalated for each year of the project's life.

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1. Whilst for the purposes of TPA analysis the completion of a certain stage of a project may be capable of generating benefits, the operating authority may not be planning to commission the project until it is completed in its entirety.

Historically, the reported annual financial results of the transport operating authorities appear to have influenced political decision making on capital allocations. Thus the estimated accounting effect expected to be generated by a proposed works programme in each of the subsequent 15 years is calculated as a bi-product of NAFET.

Contribution to Capital Recovery (CCR): as suggested by Ferrara (1976), it attempts to estimate the likely financial impact of capital expenditure, but does not include depreciation. Some of the distortions contained in the operating authority annual accounts (Bettison, 1976) due to arbitrary depreciation practices are thus eliminated. CCR thus compromises conventional accounting measures with a view to yielding results similar to, but by nature different from, those achieved by capital investment appraisal methods which utilise the discounted cash flow concept.

$$CCR = \frac{\sum_{1}^{m}\left\{\sum_{1}^{n}\left(b_{ej}-i_j\right)\right\}}{n} - RoI \times \sum_{1}^{m} K \quad \text{per annum}$$

.....where:

m, n, b_{ej}, i_j = as for NAFET

RoI = "accountants" Return on Investment

K = undiscounted budget year capital expenditure in budget year price

At the extreme, a positive $\sum_{1}^{n}(b_{ej} - i_j)$ and an objective of achieving a nil return on public investment in transport facilities and services would yield a positive CCR - meaning that the invested capital would eventually be recovered. A positive value of CCR per se has, however, little meaning especially when the community's desired return on investment is unknown. Re-arranging the above expression gives .....

$$RoI = \frac{\sum_{1}^{m}\left\{\sum_{1}^{n}\left(b_{ej}-i_j\right)\right\} - CCR\ (p.a.)}{\sum_{1}^{m} K}$$

In this case, values of RoI may be calculated for a programme using a range of CCR levels of, say, zero, equal to, and twice the depreciation which the authority concerned would charge against the asset concerned - the highest level being a conservative attempt to illustrate the significance of the asset replacement problem. Such analysis comes close to estimating whether a programme is justified in that the financial cost over future years of the investment programme, including proper allowance for a return on investment, should be offset by increased revenues and/or cost reductions of at least equal magnitude.

RoI, defined as $\frac{\text{Net Income}}{\text{Asset or Equity}}$, is a ratio often used by accountants to estimate period by period corporate

performance. When assets are the appropriate denominator, the value used is often their book value at the end of the period concerned. However, when used in conjunction with CCR as a TPA criterion, RoI cannot be influenced by the arbitrary depreciation procedures which determine an asset's book value.

In an attempt to smooth out ad hoc RoI variations from one period to another, RoI is derived over several periods.

Programme Net Present Value (NPV_{Prog}) is estimated by:

$$NPV_{Prog} = \sum_{1}^{m}\left\{\left(\sum_{1}^{n} b_{cj}\right)_{npv} - K_{npv}\right\}$$

where:

b_{cj} = annual net benefits after deducting operating and maintenance expenses etc. (but NOT capital expenditure), which are estimated to be generated by the budget year's proposed capital expenditure - in constant budget year prices.

$\left(\sum_{1}^{n} b_{cj}\right)_{npv}$ = summation of b_{cj} expressed in net present value terms.

K_{npv} = proposed budget year capital expenditure in budget year prices expressed in net present value terms.

In computing NPV_{Prog} all asset residual values are assumed to be zero. Whilst intended to act as a general screen, this assumption may, on some occasions, discriminate unfairly between projects. However, it does ensure that a justified programme with positive NPV_{Prog} contains high performance projects.

A range of discount rates is used, centred on the marginal interest rate charged by the State for new general loan funds (currently 9.5%). Although there are several possible techniques available by which the effects on project viability of inflation may be estimated[1] these have not been included in NPV_{Prog} in order to preserve its simplicity. Whilst NPV_{Prog} is the aggregate net value in present day dollars of a large number of projects with service lives of less than and equal[2] to the TPA analysis period, the "service life" of a total programme or an expenditure category is highly likely to be the full TPA analysis period. Thus the comparison of programmes and categories by NPV_{Prog} is possible on an equal investment lives basis.

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1. Most of which yield differing results and are the subject of several unresolved arguments for and against.
2. Projects whose expected service lives exceed the TPA analysis period are truncated to the analysis period.

Programme Capital Efficiency: NPV_{Prog} does not differentiate between programmes which may have similar net present values, but differ by the efficiency with which capital funds are used. This is illustrated by two hypothetical programmes, A and B, viz:

		Programme A	Programme B
K	($ Mill.)	20	50
NPV_{Prog}	($ Mill.)	60	60

Clearly programme A makes the more efficient use of capital and capital shortage would cause us to favour A over B. A valuable criterion with which to assess proposed capital investment programmes would thus be one which seeks to maximise the expected return from each dollar invested(1).

$$\text{Programme Capital Efficiency } (\eta_{Prog}) = \frac{NPV_{Prog}}{K}$$

$\eta_{prog.}$ thus enables efficiency comparisons to be made of:

- programmes proposed by different authorities,
- a newly proposed programme with those proposed by the same authority in previous years,
- an authority's originally proposed programme with a revised one including and/or deleting some projects.

Programme Internal Rate of Return (IRR_{Prog}): is the discount rate at which $NPV_{Prog} = 0$. That is, when ...

$$\sum_{1}^{m} \frac{\left(\sum_{1}^{n} b_{cj}\right)_{npv}}{K_{npv}} = 1.0$$

IRR_{Prog} for the budget year capital expenditure is calculated from ...

for Divisible Projects	for Indivisible Projects
... budget year capital expenditure and net benefits attributable to budget year capital expenditure.	... complete project capital costs and total net benefits expected from completed project.

1. The COBA scheme, used by the UK Department of Environment, also uses $\frac{NPV}{K}$ as a means of recommending funding priorities for the large number of trunk road proposals which are expected to yield a positive net present value (Gwilliam and Mackie, 1975).

IRR_{Prog} is used to:

- sum up the performance of each expenditure category and the complete programme, independently of the size of the programme - that is, as an alternative to η Prog,
- produce a ranking of projects useful in tailoring a final programme to available funds.

Sometimes projects which are not, in a discounted cash flow sense, expected to yield a positive return are included in proposed programmes. Nevertheless, for policy reasons the Government or operating authority may wish to proceed regardless of the financial result - perhaps relying on the TPA concept of support from more viable portions of the programme. In searching for a discount rate which balances capital costs against net non-capital benefits IRR computations for specific projects or relevant expenditure categories may pass through zero to the appropriate negative rate. Since at this point there can be no "return", the phrase "internal rate of consumption" is probably more appropriate. The TPA program calculates an internal rate of return, or consumption, up to near the limit of $-\infty$ % which is reached when $(\Sigma b_j)_{npv}$ equates to zero.

IRR_{Prog} accommodates the wide range of individual project service lives in the same was as for NPV_{Prog}. In ranking individual projects, those with service lives less than the TPA analysis period are assumed not to be repeated after their expiration, but the funds then released are optimistically assumed to earn at the same internal rate of return as calculated for the project. Middleton (1971) explains that under this assumption the project IRR is unaffected by service life; individual projects can thus be ranked over the common TPA analysis time period.

The Rules

Basically TPA regards a programme as being justified if:

- taking one year with another, it is at least self-liquidating,
- each of the five TPA criteria achieves an acceptable value,
- projects with total capital costs of about $0.5 million or more are justified by PPA.

There may be some exceptional projects which could be justified outside the TPA criteria. These may be projects with important policy implications either because they explicitly and individually are required by Government policy or those which may be affected by important policy considerations. In these cases the expenditure is included in TPA, but the established PPA is also used to form an opinion regarding justification.

Further, the Total Programme approach, to date, takes no account of socio-economic benefits[1]. However, where they have been quantified, socio-economic benefits are taken into account in PPA applied to large doubtful projects.

Since it is unlikely that all proposed projects will be quantified the self-liquidation rule means that, to be justified, the unquantified portion of the programme will have to be "supported" by that portion quantified and found to be viable. Thus as the proportion of unquantified projects increases, so must the viability of the quantified projects. This intentional "loophole" allows operating authority managements to propose a programme which includes projects whose justification they believe cannot be expressed quantitatively. However, to compensate, TPA limits the horizon of the aggregate net benefit stream supporting a programme to 15 years beyond the budget year - regardless of the economic or physical lives of the assets concerned.

The projects forming each programme are classified, by expenditure purpose, into one of the following categories:

Category	Purpose of Proposed Expenditure
PROFIT EARNING (PE)	- to increase net revenue through increased gross revenue
COST REDUCTION (CR)	- to increase net revenue by reducing operating costs
ASSET RENEWAL AND REPLACEMENT (AR&R)	- to renew or replace existing assets to their original condition or capacity
INDUSTRIAL & STAFF(I&S)	- to preserve industrial relations harmony and/or to accommodate staff
OTHER	- for purposes other than above, including safety, public policy, customer service

Wherever possible, the individual project evaluations from which TPA data is taken are of the "preferred alternative/do nothing base case" type as compared to, say, a "least cost/dearer alternative" type. In this way the risk of assuming that a decision has already been taken to invest is avoided. In contrast where a project results from specific Government direction then data from a "least cost ..." basis may be accepted.

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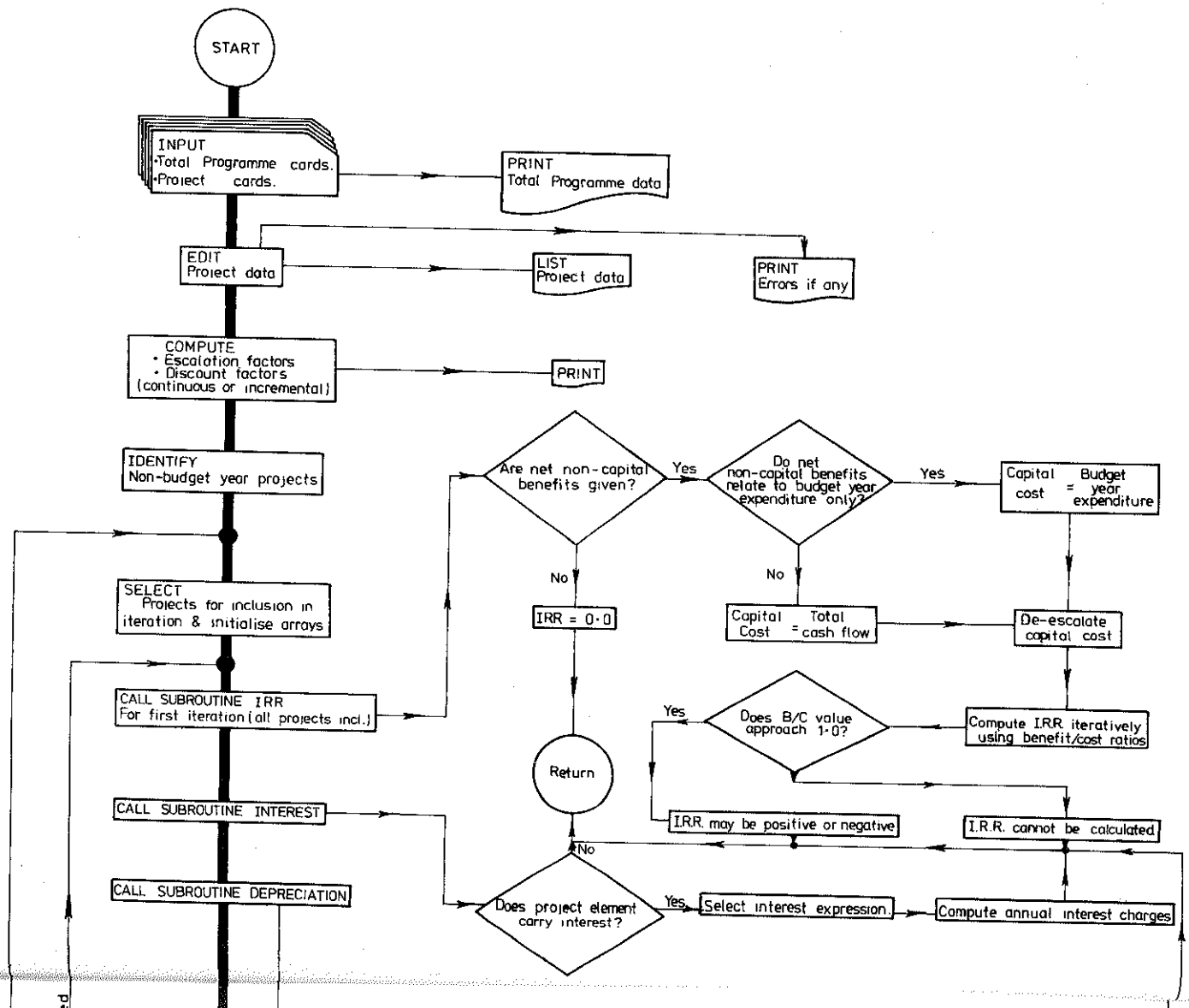
1. Socio-economic benefits generated by urban public transport projects will be embraced by TPA in the 1979-80 budget round.


START
INPUT
•Total Programme cards.
•Project cards.
PRINT
Total Programme data
EDIT
Project data
LIST
Project data
PRINT
Errors if any
COMPUTE
• Escalation factors
• Discount factors
(continuous or incremental)
PRINT
IDENTIFY
Non-budget year projects
SELECT
Projects for inclusion in iteration & initialise arrays
CALL SUBROUTINE IRR
For first iteration (all projects incl.)
CALL SUBROUTINE INTEREST
CALL SUBROUTINE DEPRECIATION
Are net non-capital benefits given?
Yes
Do net non-capital benefits relate to budget year expenditure only?
Yes
Capital cost = Budget year expenditure
No
IRR = 0·0
No
Capital Cost = Total cash flow
De-escalate capital cost
Yes
Does B/C value approach 1·0?
Compute IRR iteratively using benefit/cost ratios
Return
I.R.R. may be positive or negative
I.R.R. cannot be calculated
No
Does project element carry interest?
Yes
Select interest expression
Compute annual interest charges

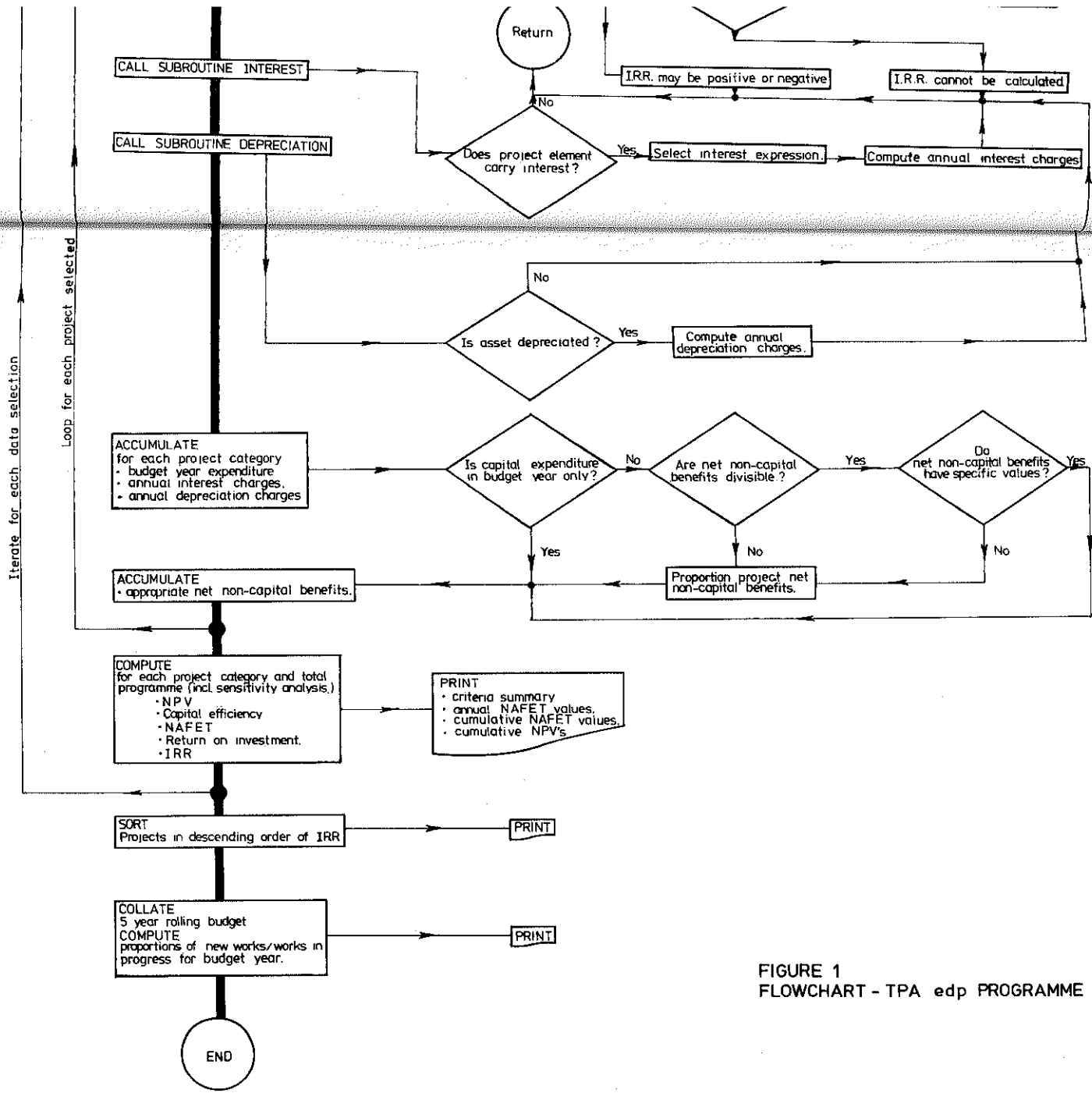


FIGURE 1
FLOWCHART - TPA edp PROGRAMME

Processing TPA Data*

The raw TPA data is supplied by the operating authorities on forms designed for direct punching onto EDP cards, in accordance with an instruction manual (Bettison & Wildermuth, 1978). The data is processed by a computer program written in FORTRAN IV and run on an IBM 370/135 DOS computer. The memory storage capacity needed is dependent upon the number of projects in any one works programme(1).

A flow chart which describes the TPA program is shown on Figure 1 above.

TPA IN ACTION

In addition to estimating the performance of a programme as proposed by an authority, TPA may be used to quickly show how the performance may be varied through the exclusion, or retardation, of specific projects. Since the mix of new works in progress must influence the performance of the total programme, both expenditure categories are embraced by TPA. The facility has thus been created by which decision makers may objectively consider, in the light of current market forecasts and with a knowledge of new projects competing for scarce funds, whether incomplete projects commenced in previous years should proceed at all in the budget year, or if so, by what rate.

This section shows, through practical examples drawn from various stages of the 1978-9 budget cycle, TPA in action as both a planning and decision-making tool.

Significant of Large Projects

Figure 2 shows the strong dependency which the justification for the $29 million Westrail preliminary programme had on the performance expected from the proposed $15 million expenditure on the rehabilitation and upgrading of the standard gauge line between Kalgoorlie and Kwinana.

Whilst the cumulative NPV_{Prog} for the programme excluding this project goes less into the "red" than the total programme, by about 1989-90 it commences being rapidly overtaken by the total programme. Figure 3 illustrates that the annual accounting performance of the total programme was also very dependent upon the large project.

An alternative application of the project significance facility is in quantifying the extent of the negative pull which some large projects, found to be unjustified by

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* The author wishes to acknowledge the valuable assistance given by his colleague, Hugo Wildermuth, in this area.

1. In the 1978-9 budget round the largest programme allowed for comprised 150 projects and this required a memory capacity of 48k bytes (12k words).

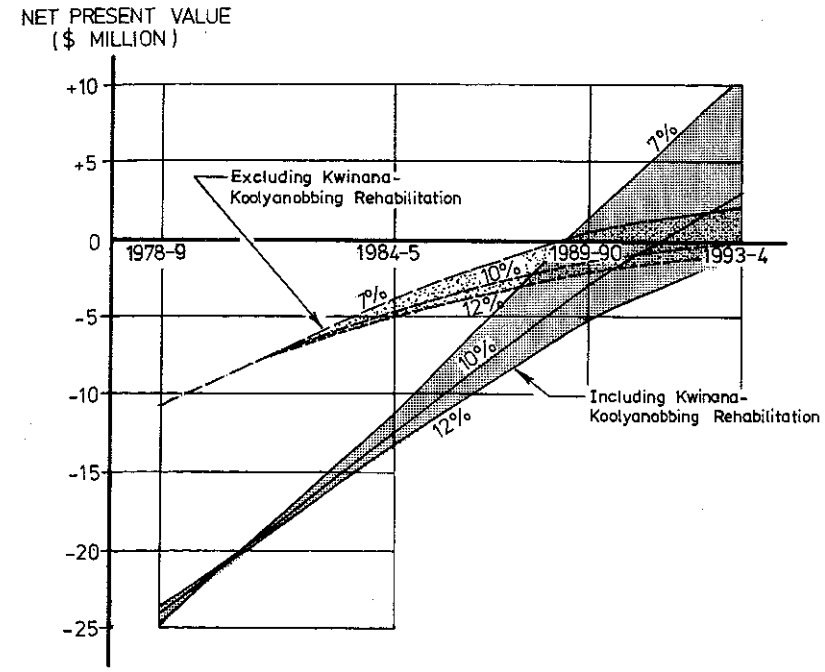

FIGURE 2
DEPENDENCE OF PROGRAMME PERFORMANCE ON LARGE PROJECTS
—CUMULATIVE NPV AT VARIOUS DISCOUNT RATES—
(Westrail Preliminary Proposed 1978-9 Programme)

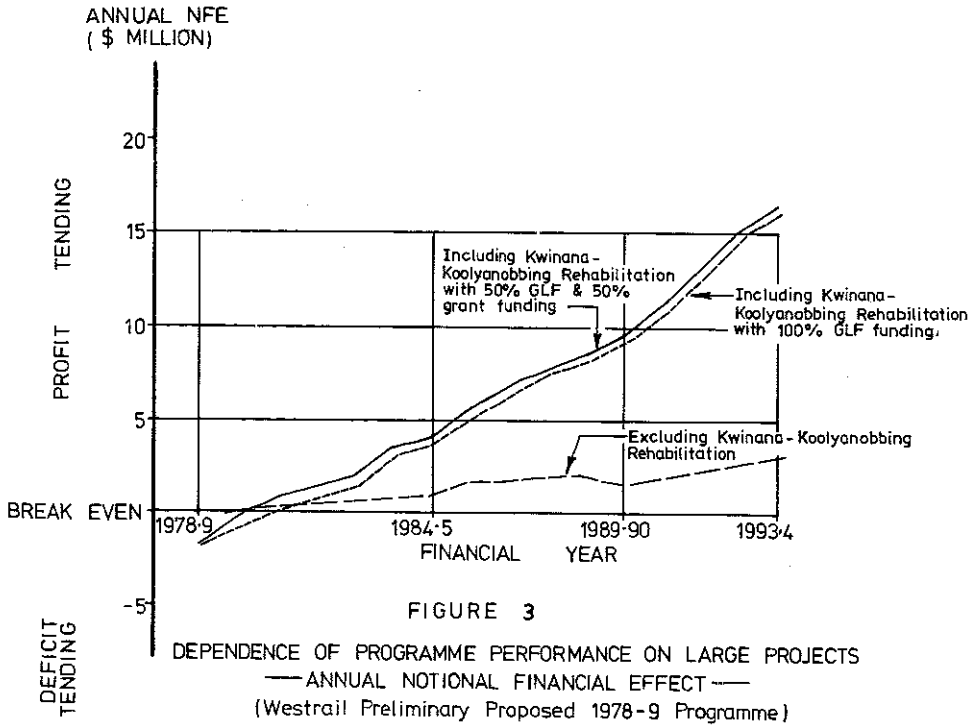

FIGURE 3
DEPENDENCE OF PROGRAMME PERFORMANCE ON LARGE PROJECTS
—ANNUAL NOTIONAL FINANCIAL EFFECT—
(Westrail Preliminary Proposed 1978-9 Programme)

PPA, have on the total programme's performance. Figure 4 shows that the MTT's preliminary programme cumulative NPV_{Prog} would be significantly improved if either, or both, the proposed expenditures of $1.5 million and $4.4 million for bus fleet expansion and bus replacement respectively were deleted.

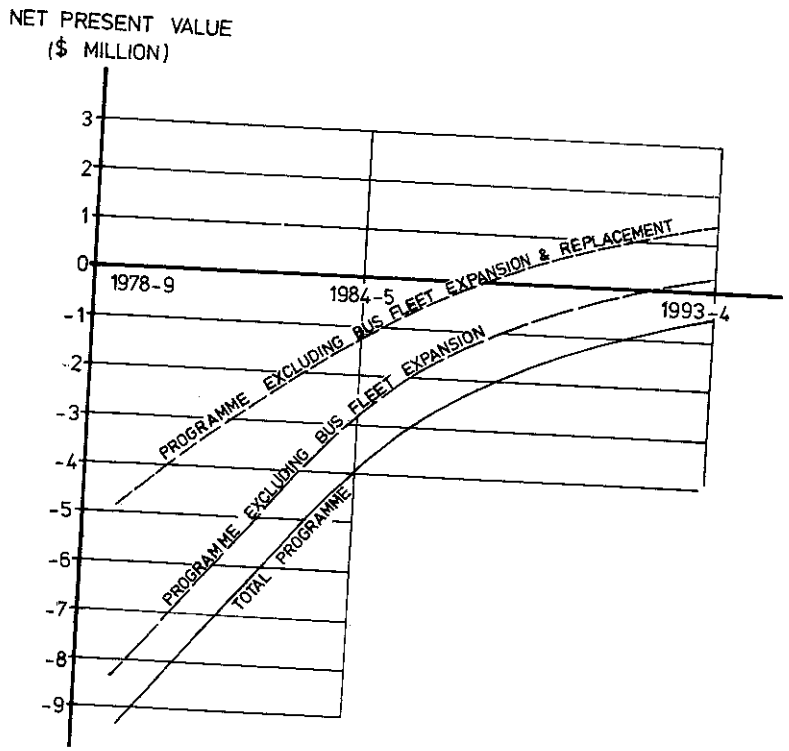

FIGURE 4
EFFECT OF UNJUSTIFIED LARGE PROJECTS ON CUMULATIVE NPV
(MTT Preliminary Proposed 1978-9 Programme)

Table 2 shows TPA criteria changes due to project deletions.

TABLE 2
EFFECT ON TPA CRITERIA OF PROGRAMME DELETIONS

	Programme		
	Proposed	Excl. Bus Fleet Exp'n	Excl. Bus Rplcmt
NAFET ($ Mill.)	1.011	1.029	0.990
RoI (a) (Acc. $/$ invstd.)	0.04	0.05	0.09
NPV_{Prog} (b) ($ Mill.)	-0.467	+0.374	+0.544
Σ_{Prog} (b) ($NPV/$ invstd)	-0.04	+0.04	+0.08
IRR_{Prog} (%)	9.0	10.6	11.2

(a) With CCR set at twice existing depreciation.
(b) At 10% discount rate.

Significance of Expenditure Categories

A useful indication of where a programme's strengths and weaknesses lie is given by the TPA criteria for each expenditure category - as illustrated in Table 3 below.

TABLE 3
PERFORMANCE OF EXPENDITURE CATEGORIES (a)

TPA Criterion	Expenditure Category					
	PE	CR	AR &R	I & S	Other	Total Prog.
NAFET ($ Mill)	2.094	0.635	1.881	-0.047	-0.007	4.556
RoI (b) (Acc.$/$ Invstd)	0.24	0.41	0.14	-0.12	-0.05	0.18
NPV (c) ($ Mill)	1.734	1.982	-0.394	-0.548	-0.358	2.41
η_{Prog} (c), ($NPV/$ invstd)	0.23	1.48	-0.04	-0.96	-0.45	0.12
IRR_{Prog} (%)	13.0	28.3	9.6	Neg.	Neg.	11.7

(a) Westrail final proposed 1978-9 programme.
(b) With CCR set at twice existing depreciation.
(c) At 10% discount rate.

Clearly whilst the total programme achieves TPA justification, the high performance PE and CR categories give strong support to the weaker ones. These results thus enable authority managements to consider improving expected TPA performance through deletion or replacement of poor projects in the weak categories.

Sensitivity Testing

As required TPA may be used to estimate the sensitivity of a proposed programme to changes in future rates of inflation, discount rates and funding sources. Figure 2 above illustrates the impact of the discount rate on both the total and residual programmes whilst the influence of the funding source is shown in Figure 3 above.

Capital Shortage Strategy

Table 4 below gives the recommended capital shortage strategy for the $29 million preliminary programme proposed by Westrail - which passed all five TPA criteria.

Since PPA detected some projects which were plainly not justified, the recommended programme was $1.5 million less than that proposed - regardless of any funding constraint.

The above strategy thus informs decision-makers of the funds needed to yield a required return or alternatively

suggests the return which may be earned if a given sum were allocated. In practice both "sides" of the strategy influence the decision.

TABLE 4
RECOMMENDED CAPITAL SHORTAGE STRATEGY

Shortage Stage	Justified Expenditure Mill.$.	Recommended Programme Deletions
No shortage	27.512	Projects "Not Justified" by PPA
1	27.387	Projects "Marginally Justified" by PPA All projects with an IRR of less than . . .
2	25.534	Zero
3	23.615	7.7%
4	22.295	9.0%
5	21.711	12.5%

Changes in Programme Performance

Table 5 below shows, through a full set of TPA criteria, the consistently large improvements which MTT achieved between the preliminary and final 1978-9 programmes.

TABLE 5
TPA CRITERIA CHANGES DURING BUDGET CYCLE

	MTT 78-9 Proposed Programme	
	Preliminary	Final
Capital Expend. Proposed ($Mill)	9.9	4.0(a)
NAFET ($ Mill)	1.011	1.566
RoI (b) (Acc'g $/$ Invested)	0.04	0.34
NPV_{Prog} (c) ($ Mill)	-0.467	3.224
η_{Prog} (c) ($NPV/$ Invested)	-0.04	0.85
IRR (%)	9.0	22.7

(a) Plus $4.9 million lease-back.
(b) With CCR set at twice existing depreciation.
(c) At 10% discount rate.

The above changes resulted from:
- deletion of some poor projects
- inclusion of more justified projects
- revised proposed funding sources
- improved project evaluations

In particular, Figure 5 illustrates the improvement in NPV_{Prog} which was effected.

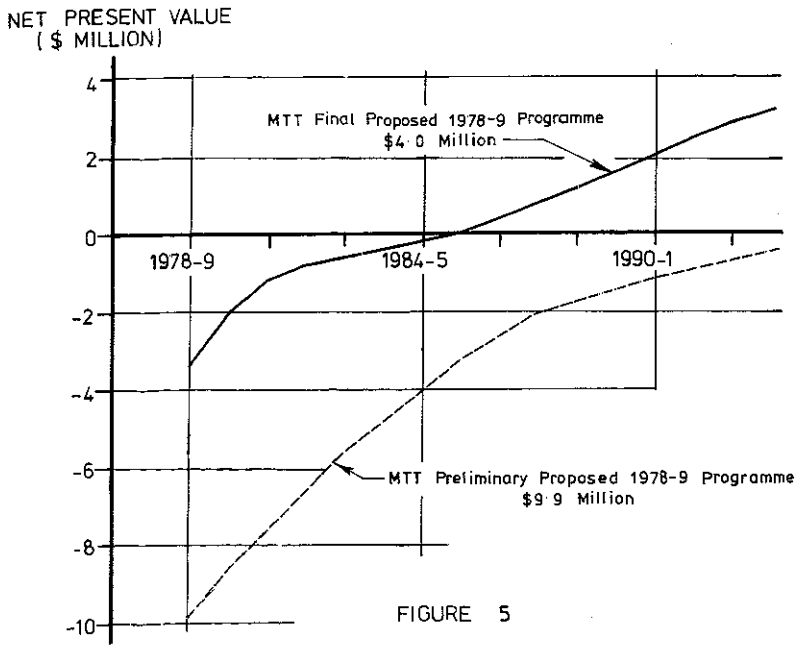

FIGURE 5

COMPARISON OF PRELIMINARY & FINAL PROGRAMMES
BY CUMULATIVE NET PRESENT VALUE
(10% Discount Rate)

Programme Attractiveness

As the gap between expenditure proposals and available public funds increases so must the competitive nature of each authority's programme. TPA assists each operating authority to quantify the expected performance of its proposed programme so as to make it as attractive as is possible to the suppliers of financial support.

Although other non-quantifiable factors often need to be taken into account in the allocation of funds, TPA permits comparison of the quantifiable aspects of competing programmes as is shown in Table 6 below.

Table 6 suggests that the MTT programme was the more attractive. Figure 6 below illustrates the disaggregated support which can be used to expand the comparison base of Table 6.

TABLE 6
RELATIVE ATTRACTIVENESS OF CAPITAL PROGRAMMES

TPA Criterion	Final 78-9 Prog. Proposed by	
	Westrail	MTT
Capital Expenditure Proposed ($ Mill.)	25.658	4.0 (plus 4.9 leaseback
NAFET ($ Mill.)	4.556	1.566
RoI (a) (Acc. $/$ Invested)	0.24	0.45
NPV_{Prog} (b)	2.418	3.224
η_{Prog} (b) ($NPV/$ Invested)	0.12	0.85
IRR (%)	11.7	22.7

(a) With CCR set at zero[1]. (b) At 10% discount rate.

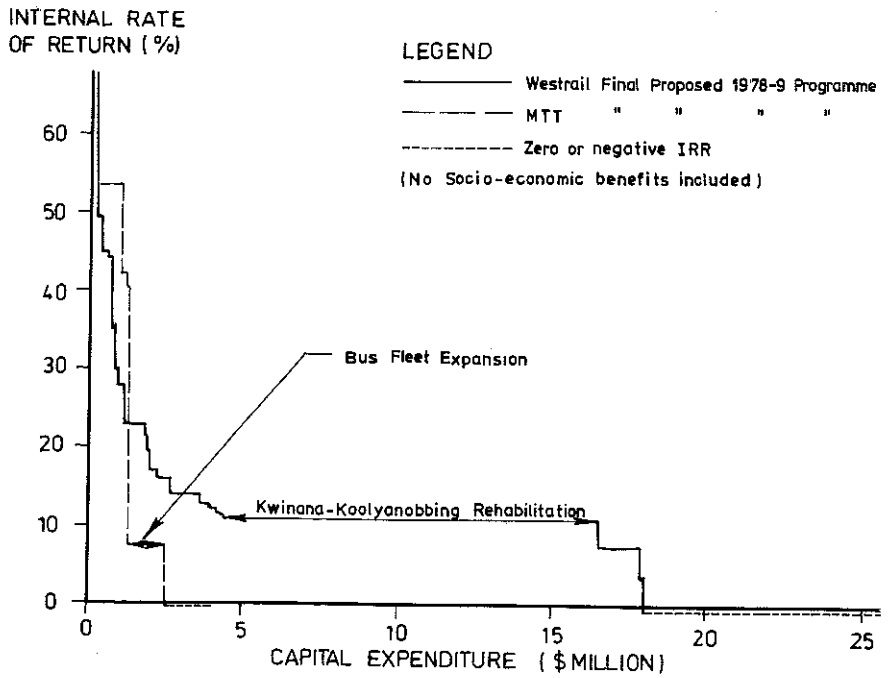

FIGURE 6
COMPARISON OF AUTHORITY PROGRAMMES BY IRR

1. Comparison of programmes may best be performed with CCR set to zero since any other level (other than a unilateral policy) would be likely to be more appropriate to one authority than another.

ROGRAMMES

ɔg. Proposed by MTT
4.0 (plus
4.9 leaseback
1.566
0.45
3.224
0.85
22.7

count rate.

ɔsed 1978-9 Programme
" "
RR
ɔcluded)

20 25

BY IRR

ormed with CCR
than a
more appropriate

FURTHER DEVELOPMENTS

With TPA successfully introduced, and full coverage by it of all publicly owned transport operating authorities now in hand(1), some attention has been given to further developing TPA so as to maximise its potential as a means of collating, co-ordinating and justifying investment proposals. Four areas currently being pursued are described below.

Negative IRR Values

Consideration is being given to the obstacles to calculating negative internal rates of return when an individual project's $(\sum_1^n b_j)_{npv} \leq 0$. This may result from it being included in a programme through a public policy directive to proceed with a non-remunerative project, or due to an incomplete quantification of benefits. Although a theoretical possibility, it is unlikely that $(\sum_1^n b_j)_{npv}$ for a proposed total programme would be as low as zero or negative.

Integrated Budget Performance

TPA has the potential to describe the performance of an integrated transport budget, being the collective works proposed by all the operating authorities. This advice will be particularly useful in Ministerial "share of the cake" negotiations which occur at the climax of the budget cycle. It is expected that integrated budget TPA performance criteria will be available during the 1980-81 budget round.

Forward Planning and Expenditure Timing

All Western Australian transport authorities annually develop a 5-year rolling budget which is collated into an integrated transport budget by the DGT. However, the Western Australian Treasury's requirement of a 3-year forward programme (2) suggests the first 3 years as the period in which it would be useful to optimise integrated and individual authority programme performances - within the constraints of practicability. As well as being a useful operating authority budgeting tool a TPA optimisation would provide an objective means through which the DGT's duty of "..... recommending times for the commencement and completion of programmes" (Western Australia, 1966) may be pursued.

Under this scheme as much as practicable of the expenditure proposed in all three years would be evaluated and nominally scheduled for implementation in a given year.

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1. The programmes of the Fremantle and regional port authorities and the Harbour and Light Department are being gradually phased into TPA commencing with the 1979-80 budget round.
2. Treasury's 3-year period is consistent with the 3-year "design list" period requirement of Loan Council.

Two optimising techniques which could be used are:

- intuitive selection and year to year interchange of major projects with a subsequent testing for improvement in TPA criteria - methodologically simple but possibly slow. Although improvements in TPA criteria may be achieved, this technique offers no yardstick as to optimality.

- deterministic optimisation via linear programming techniques. Constraints would include the non-quantification of some significant investments and the practical need to proceed with some projects regardless of their place in an optimised set of annual programmes.

Capital Shortage Strategy Refinement

A comprehensive capital shortage strategy may aim to satisfy one or more objectives which could include:

(a) making the most efficient use of scarce funds,
(b) implementing specific government policy.

Assuming that (b) will be executed, the complementary pursuit of (a) calls for a definition of efficiency in this context and a means of ranking projects in thier efficiency order. One practicable definition of an efficient programme could be that package of projects which yields the greatest NPV_{Prog} for a given capital availability. Projects may be ranked by:

- project NPV - which may be contrary to the efficiency objective,
- project IRR - as currently used for TPA ranking; one unique conceptual advantage being that IRR is independent of the discount rate,
- project capital efficiency.

The appropriateness of these alternative ranking criteria is currently being studied. Figures 7 (a) and (b) below compare the profiles of cumulative NPV_{Prog} against cumulative capital expenditure for these three ranking criteria.

Figures 7(a) and (b) show that, in this test case, none of the ranking criteria gives a continuous lead in cumulative NPV for a given amount of capital expenditure. However, the single large steps in each criterion's "curve" illustrates the impact which one large project can have on overall ranking. Further empirical analysis is in hand to compare the rankings in the absence of large projects and, it is hoped, to develop a consistent capital shortage strategy ranking system. It may also be possible to undertake a theoretical comparison of alternative ranking systems.

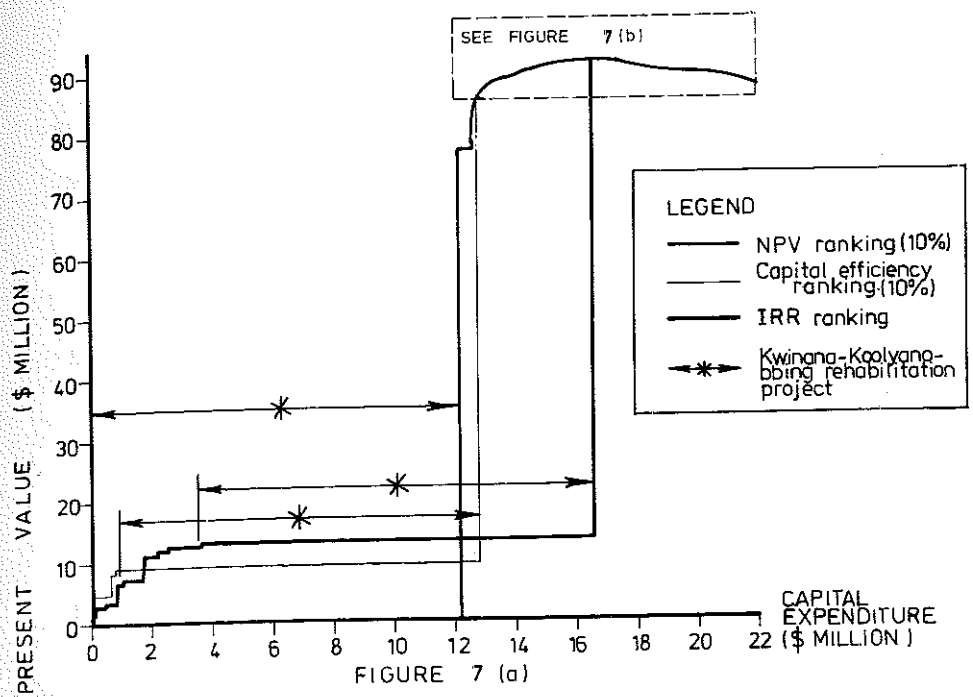

FIGURE 7 (a)

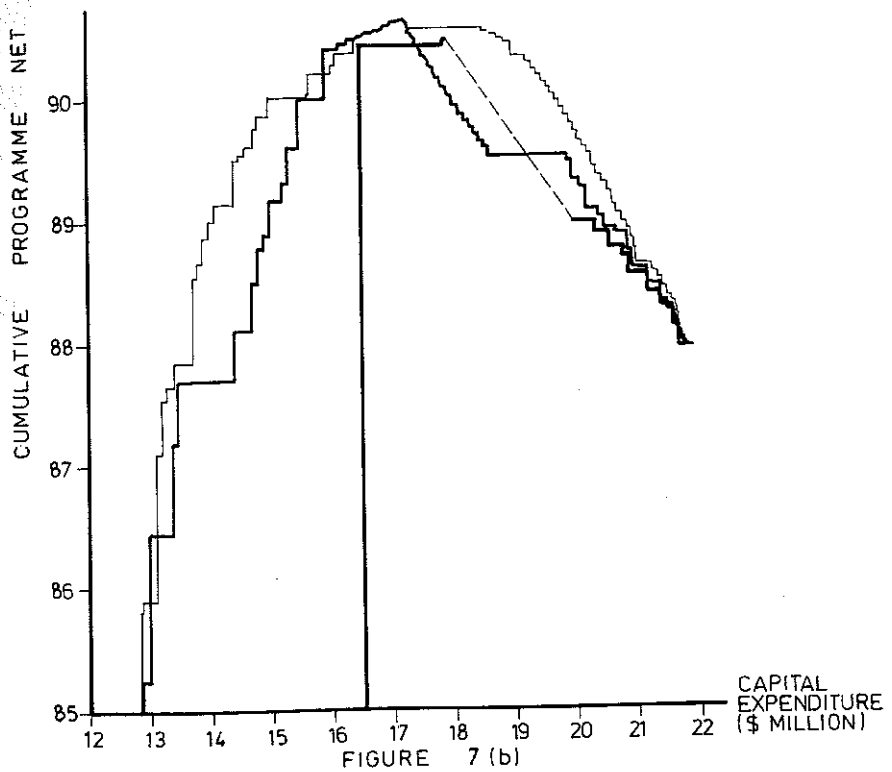

FIGURE 7 (b)

EFFECT OF PROJECT RANKING CRITERIA ON PROGRAMME NPV

(Using Westrail final proposed 1978-9 programme as case study)

Funds for transport authority capital programmes originate from various sources at differing interest rates. Obviously the aggregate cost of programme funding should influence project selection and this aspect is also being studied in the context of capital shortage strategy development.

CLOSING REMARKS

Although relatively simple in concept, TPA appears to be a unique and successful tool in justifying proposed capital expenditures in the public sector. Because of the substantial benefits which TPA can yield in the formative stages of programme development, TPA is now being made available to transport operating authorities in Western Australia for their internal use.

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