GUIDELINES FOR THE INVESTMENT CHOICE OF CAPITAL PROJECTS BY PUBLIC CORPORATIONS

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Abstract

This article provides guidelines on how public corporations can choose capital projects on the basis of economic and financial criteria. Project appraisal, selection and prioritisation criteria are listed, followed by a description of the way in which the result of each appraisal technique should be interpreted. Criteria that should be adhered to in the selection of mutually exclusive projects and the prioritisation of functionally independent projects in order to maximise the net output of public corporations in the long run are supplied. Applications of the proposed investment decision rules are illustrated by examples. Two techniques are proposed that may be used as additional decision-making instruments when evaluated projects show similar degrees of long-term financial viability.

Keywords: benefit: cost ratio; capital recovery period; first-year rate of return; incremental benefit: cost ratio; independent projects; indivisible projects; mutually exclusive projects; net present value

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1. GENERAL

The problem of scarcity of resources leads to budget limitations at all levels of decision making. This – along with the fact that commercialised public corporations' investment in capital projects consumes a relatively large proportion of their available funds – means that they have to be certain that the benefits offered by capital investments exceed the costs thereof. However, candidate capital projects must not only be subject to sound investment appraisal, but those chosen for implementation should also collectively maximise benefits. The research question is twofold: first, how to determine the appropriate size of an investment budget of indivisible* capital projects; and, second, how to compile a budget of a given size (i.e. how to allocate a fixed total of funds) among mutually exclusive* and independent projects.*

2. DECISION RULES FOR PROJECT SELECTION AND PRIORITISATION

2.1 Selection criteria

The selection and prioritisation of projects based on investment appraisal usually takes place with reference to the following general criteria (Pienaar, 2002; European Commission, 2008):

(1) All projects must be evaluated in the same manner.

(2) All alternatives, i.e. the whole range of technically feasible projects, should be evaluated.

(3) The benefits of a project must exceed its investment cost.

(4) The investment cost of a chosen project must be within the limits of the budget.

Evaluation techniques to determine the viability of a project are usually based on the following three specific criteria:

(1) Minimum total cost, which can be determined through the present worth of cost (PWOC)* technique (expressed as an absolute monetary amount).

(2) Net advantage, which is determined by the net present value (NPV)* technique (expressed as an absolute monetary amount).

(3) Relative advantage, which is usually determined either by the benefit:cost ratio (B/C)* technique or the internal rate of return (IRR)* technique (expressed in relative terms; the former as a ratio and the latter as a percentage).

[*] All concepts marked with an asterisk, are defined in the glossary of terms (section 6).

The financial choice of a specific project for implementation involves two steps, namely, project selection and project prioritisation:

- **Project selection** involves the selection of the best mutually exclusive project, or in other words, the most advantageous way of solving a specific operational problem.
- **Project prioritisation** is the arrangement of all functionally independent projects in order of priority according to their respective degrees of viability. The projects will be prioritised from most to least attractive up to the point where the capital budget has been exhausted.

A project which yields a B/C ratio value greater than 1 always has a positive NPV, and an IRR which exceeds its opportunity cost of capital. Provided the initial costs of projects do not differ, any one of the four evaluation techniques discussed may be used to select the best alternative among a number of mutually exclusive projects. The alternative with the smallest PWOC will have the highest B/C ratio, highest IRR and highest NPV. However, if the initial costs differ significantly (which is generally the case), incremental analysis should be used to identify the most suitable alternative (Adler, 1987).

The PWOC and NPV techniques cannot be used to prioritise independent projects. The absolute value of a project's benefits depends on its scope. The benefits of a large project may, for instance, have a larger absolute value than the benefits of a smaller project, whereas the relative return of the larger project may be considerably lower than that of the smaller project. Hence it is better to use the IRR and B/C ratio techniques for the prioritisation of independent projects, also taking into account the results of the investment timing analyses (Canadian Treasury Board, 1998).

The reduction of user cost afforded by new facilities can generate additional demand over and above normal demand. In such cases, the criterion of lowest total cost presents a contradiction in terms which complicates the interpretation of the answer indicated by the PWOC technique. Furthermore, this answer does not give an indication of the scale of the benefit offered by an alternative, unless the answer is subtracted from the PWOC of the existing alternative. This difference is equal to an alternative's NPV (Pienaar, 2002).

It is the creation of net benefit that is of interest to the decision maker, because it is benefit that contributes to wealth, and, therefore, to economic welfare (AASHTO, 2003). To support informed decision making, further analysis in this work focuses on the evaluation techniques which take cognisance of project benefits.

In the sections that follow, the principles of selecting divisible and indivisible projects with a fixed budget and with a variable budget size are discussed.

2.2 Divisible projects

Consider first the situation where all projects are divisible, i.e. they can be increased or decreased by very small increments. Although this is not a realistic assumption, it allows us to illustrate the basic rationale of project selection.

Fixed budget size

Suppose that the decision maker must be advised how best to allocate a given amount, say €1 million, between two proposed projects, X and Y. The problem is similar to that of an individual who must allocate his personal budget. First, one must determine the cost (C) involved in providing each service and the benefit (B) to be derived from each service. Then outlays must be allocated between X and Y in order to maximise the net benefit from the budget (ΣNB), i.e. to derive the largest excess of total benefits over costs $\Sigma(B - C)$. With ΣC limited by the size of the budget, the task is to maximize ΣB.

Variable budget size

More broadly viewed, budgeting indicates that the problem is not merely one of compiling a given budget, but also of determining its size. The government must thereby decide how resources are to be distributed between private and public use. Therefore, one has to drop the assumption of a fixed budget and integrate project choices along with the process of determining total budget size(s). Within a fixed budget, the opportunity cost of pursuing a public project consists of the benefit forgone by not pursuing the best other public project. But in a variable budget situation the opportunity cost of public projects must be considered as the lost benefits from private projects which are forgone because resources are transferred to public use.

The task now is to maximize $\Sigma(B - C)$, including benefits and costs of both public and private projects. This condition is met by equating marginal benefits for the last euro spent on alternative public and private projects. Public projects are extended or restricted and private projects are restricted or extended until the benefit from the last euro spent in either sector is equal. Thus, public investments are increased until the last euro spent yields a euro's worth of benefits.

2.3 Indivisible projects

It is assumed above that investment may be divided between projects, or broad categories, X and Y, so that benefits may be equated for the marginal euro spent on each. With specific allocation within public corporations, choices must be made among indivisible projects. These projects involve lump-sum amounts and are not smoothly expandable. If, for example, the choice has to be made between a road linking points A and B and another linking A and C, where the distance between A and B is twice the distance between A and C, no marginal extension appears possible. This situation contrasts with, for example, the construction of an access road into a developing region, which may be expanded by small increments.

Fixed budget size

Consider a fixed budget situation. Suppose that the government has €1 million to invest in different infrastructure facilities, and that it may choose among projects A to G, as shown in Table 1. The cost of each project is represented by its required investment amount. The benefit assessment gives the total benefit for each project.

Table 1. Project choice with indivisible projects and a fixed budget

Project	Present value of benefits: B (€ 000)	Present value of investment cost: C (€ 000)	Net benefits: B-C (€ 000)	B/C ratio	B/C ranking
A	215	70	145	3,1	1
B	180	115	65	1,6	4
C	300	210	90	1,4	5
D	190	170	20	1,1	7
E	565	435	130	1,3	6
F	720	430	290	1,7	3
G	685	285	400	2,4	2

In dealing with this case, one can consider various decision rules. Let rule 1 be to rank projects in line with their B/C ratio and move down the order until inclusion of a further project would exceed the budget limit. Projects A, G, F and B are then chosen. The total investment cost is €900 000; total (i.e. gross) benefits are €1 800 000; net benefits equal €900 000; and €100 000 of the available budget remains. As an alternative, let rule 2 call for that mix of projects which yields the largest net benefit. By trying various combinations, one finds that net benefits are maximised by choosing projects A, G, F and C. In this case, the total investment cost is €995 000; gross benefits are €1 920 000; and net benefits equal €925 000. An amount of €5 000 is not invested. Rule 3, finally, might be to minimise the residual not invested, subject only to the constraint that projects must have a B/C > 1. In this case, the choice is for projects B, D, F and G, with a cost of €1 000 000, benefits of €1 775 000 and net benefits of €775 000. No funds remain.

Comparing the merits of the three rules shows that it is evident that rules 1 and 2 are superior to 3 because both realise greater benefits at a smaller investment cost. Choosing between rules 1 and 2 is more difficult. Rule 1 is reasonable, because it calls for the choice of projects which yield the highest return per euro of the constrained resource (i.e. the available budget). Rule 2 offends this principle by choosing project B over C. Yet by moving from rule 1 to rule 2, additional benefits of €120 000 are gained at an additional investment cost of €95 000. Net benefits rise by €25 000, and although the incremental B/C ratio* is only 1,26, it is still a viable proposition. Rule 2 will clearly be preferred if the fixed budget case treats any unutilised funds as worthless. Taking a broader view and allowing for a possible transfer to another budget, one notes that rule 2 will be better only if other budgets cannot offer projects with a B/C ratio above 1,26.

Variable budget size

If the budget size has no fixed limit, the problem is once more one of weighing public against private uses of resources. Since one is now dealing with indivisible projects, this can no longer be done by balancing the benefits derived from incremental outlays on both uses. One now proceeds by the rule that a public project is worth undertaking as long as its benefits exceed its investment cost. The justification for the rule is that the cost of investing n euros in the public sector is the loss of n euros of benefits – a loss which results from not investing n euros in the private sector. The rule may be postulated that a project should be undertaken so long as $(B - C) > 0$ (Musgrave and Musgrave, 1989; Rosen and Gayer, 2008; Black, Calitz and Steenekamp, 2005).

3. APPLICATION OF INVESTMENT DECISION RULES

3.1 Mutually exclusive projects

Whenever the opportunity prevails to solve a specific problem with the investment timing of the solution project not being challenged by any independent projects elsewhere, the NPV measure is the preferred selection criterion. Suppose, for example, that €1 million has been allocated to rectify a specific problem situation, that unused funds cannot be transferred to other projects and that a choice has to be made from the three viable alternatives shown in Table 2.

Table 2. Present value of benefits and investment costs for three alternative projects

Project	Present value of benefits (euros)	Present value of investment cost (euros)	Net present value of benefits (NPV) (euros)	B/C ratio
A	1 080 000	600 000	480 000	1,80
B	1 400 000	800 000	600 000	1,75
C	1 620 000	1 000 000	620 000	1,62

Regardless of the fact that alternative C shows the smallest relative return, it maximises absolute benefit by having the greatest NPV. Incremental B/C analysis using Table 2 shows that a move from alternative A to alternative B and a move from alternative B to alternative C will both be beneficial:

- $B/C_{B:A}$ = (1 400 000 – 1 080 000) ÷ (800 000 – 600 000) = 1,6
- $B/C_{C:B}$ = (1 620 000 – 1 400 000) ÷ (1 000 000 – 800 000) = 1,1

Therefore, a move from alternative A to alternative C will yield the greatest net benefit. Note that in a mutually exclusive situation, incremental analysis will always indicate that the alternative with the greatest NPV is the best project.

3.2 Independent projects

When a choice has to be made among a number of independent projects, given a fixed budget, the B/C ratio measure is the preferred criterion. Suppose, for example, a public corporation with a fixed budget of €1 million has to make a choice among 16 independent projects, five of which are indicated in Table 3.

Table 3. Present value* of benefits and costs for a number of independent projects

Project	Present value of benefits (euros)	Present value of investment cost (euros)	Net present value of benefits (NPV) (euros)	B/C ratio
A	70 000	30 000	40 000	2,33
B	270 000	150 000	120 000	1,80
C	84 000	45 000	39 000	1,87
D	128 000	60 000	68 000	2,13
.	.	.	.	.
.	.	.	.	.
P	180 000	90 000	90 000	2,00

In this situation the B/C ratio criterion is the preferred measure to apply. The project with the highest B/C value is chosen first, followed by the one with second-highest B/C value, and so on until the budget is exhausted. Therefore, the five projects in Table 3 will be chosen in the order A, D, P, C and B. This way the benefit per euro spent is maximised.

3.3 Mutually exclusive and independent projects

Suppose the objective of the decision maker is to maximise benefit subject to the restriction of a fixed budget, and that both mutually exclusive and independent projects are under consideration. In this case, a method of project assessment based on the incremental principle is recommended. The method consists of the following seven steps (Thompson, 1980; Pienaar, 2002; Conningarth Economists, 2006):

(i) Determine the size of the budget. Where the size of the budget has been given, this requirement is met. Where some degree of freedom exists as to the total amount available, then the amount can be expanded incrementally, and the marginal benefits compared with the marginal expenditure to determine whether any expansion of the budget is justified.

(ii) Eliminate all projects that exceed the budget limit and all projects that do not satisfy the minimum acceptance criteria, as set out above.

(iii) Determine which project has the highest B/C ratio within each group of mutually exclusive alternatives and then leave out the rest of the possible projects in the group.

(iv) From the projects under consideration initially, select the one with the highest B/C ratio.

(v) Reconsider the selection of the best project in each group of mutually exclusive projects by, firstly, reviewing all the more expensive projects and noting the incremental B/C ratios. Within each group of mutually exclusive projects the project with the highest incremental B/C ratio is identified and compared with the rest of the independent projects. Secondly, the available budget is adjusted to reflect the effect of the projects already chosen, and all remaining projects that exceed the balance of the budget are omitted.

(vi) Repeat steps (iv) and (v) for as long as possible. The iteration process ends when the budget is exhausted or when no acceptable projects remain for consideration.

(vii) Consider adjustments to chosen projects when the budget is not completely exhausted and a small adjustment in a chosen project may provide incremental benefits.

The following example demonstrates this procedure. Suppose a corporation has €1 million to spend on capital projects, and 13 possible projects are proposed to replace six unsatisfactory facilities (A to F). The projects under consideration are summarised in Table 4. Projects A_1 and A_2 are two mutually exclusive; B_1, B_2 and B_3 are mutually exclusive; D_1 to D_4 are mutually exclusive; and F_1 and F_2 are mutually exclusive. Groups A, B, C, D, E and F are independent.

Table 4. Present worth (PW)* of benefits and costs, and benefit:cost ratios of a number of projects

Project	PW of benefits (€ 000)	PW of investment cost (€ 000)	B/C ratio
A_1	180	150	1,20
A_2	490	350	1,40
B_1	210	100	2,10
B_2	328	160	2,05
B_3	351	180	1,95
C	270	200	1,35
D_1	180	120	1,50
D_2	432	240	1,80
D_3	630	360	1,75
D_4	816	480	1,70
E	90	40	2,25
F_1	260	130	2,00
F_2	304	160	1,90

There is no project that exceeds the budget limit of €1 million and, furthermore, there is no project with a B/C ratio of less than 1. All projects are, therefore, included in further analysis. Subsequently, from each group of mutually projects the one with the highest B/C ratio is chosen; the projects that are selected for the next step are the following:

Project	PW of benefits (€ 000)	PW of investment amounts (€ 000)	B/C ratio
A_2	490	350	1,40
B_1	210	100	2,10
C	270	200	1,35
D_2	432	240	1,80
E	90	40	2,25
F_1	260	130	2,00

From these six projects E is chosen. There is now €960 000 left in the investment budget, with five remaining projects to choose from. B_1 is subsequently chosen, which leaves €860 000 in the budget. The more expensive projects in the B group are now considered in terms of their incremental B/C ratios, as shown:

Project	Incremental benefit (€ 000)	Incremental cost (€ 000)	Incremental B/C ratio
B_2B_1	118	60	1,97
B_3B_1	141	80	1,76

Although B_1 is preliminarily chosen, B_2B_1 deserves consideration because it is financially viable (*B/C* B_2B_1>1) and more beneficial than *B/C* B_3B_1. The remaining five projects are as follows:

Project	PW of benefits (€ 000)	PW of investment amounts (€ 000)	B/C ratio
A_2	490	350	1,4
B_2B_1	118	60	1,97
C	270	200	1,35
D_2	432	240	1,8
F_1	260	130	2,0

Subsequently, F_1 is chosen, which leaves €730 000 in the budget.
Now consider the more expensive F project (F_2).
The remaining five projects are now as follows:

Project	PW of benefits (€ 000)	PW of investment amounts (€ 000)	B/C ratio
A_2	490	350	1,4
B_2B_1	118	60	1,97
C	270	200	1,35
D_2	432	240	1,8
F_2F_1	44	30	1,47

Choose B_2B_1 and €670 000 remains.
Consider B_3 against B_2.
The remaining five projects are as follows:

Project	PW of benefits (€ 000)	PW of investment amounts (€ 000)	B/C ratio
A_2	490	350	1,4
B_3B_2	23	20	1,15
C	270	200	1,35
D_2	432	240	1,8
F_2F_1	44	30	1,47

Choose D_2 and €430 000 remains.
Consider a more expensive D project. D_3D_2 is incrementally the most beneficial project.
The five remaining projects are as follows:

Project	PW of benefits (€ 000)	PW of investment amounts (€ 000)	B/C ratio
A_2	490	350	1,4
B_3B_2	23	20	1,15
C	270	200	1,35
D_3D_2	198	120	1,65
F_2F_1	44	30	1,47

Choose D_3D_2 and €310 000 remains.
Consider the more expensive D project (D_4).
A_2 falls away because its investment cost exceeds the available budget (€350 000 > €310 000), and A_1 is instead placed on the priority list.

The remaining five projects are as follows:

Project	PW of benefits (€ 000)	PW of investment amounts (€ 000)	B/C ratio
A_1	180	150	1,2
B_3B_2	23	20	1,15
C	270	200	1,35

D_4D_3	186	120	1,55
F_2F_1	44	30	1,47

Choose D_4D_3 and €190 000 remains.
Choose F_2F_1 and €160 000 remains.
C is eliminated because of an insufficient balance in the budget.
Choose A_1 and €10 000 remains.

Because €10 000 in the budget remains unutilised, the last step is to ascertain whether the best eliminated project cannot be incorporated at the cost of any chosen project in order to increase the net benefit attainable through better utilisation of the budget.

This is not the case, and the final choice of projects is as follows:

Project	PW of benefits (€ 000)	PW of investment amounts (€ 000)	NPV (€ 000)	B/C ratio
A_1	180	150	30	1,20
B_2	328	160	168	2,05
D_4	816	480	336	1,70
E	90	40	50	2,25
F_2	304	160	144	1,90
	1 718	990	728	

4. CHOOSING PROJECTS THAT SHOW SIMILAR DEGREES OF VIABILITY

4.1 First-Year Rate of Return technique

Project viability per se does not reveal the optimum timing of project implementation. For the timing of project implementation, the project should be analysed with a range of investment timings to establish the one that yields maximum viability. A project may be viable, but it may be a better project if it were delayed by one year. Delaying implementation would defer the capital expenditures, but lose a year's benefit.

When benefits are expected to grow continuously in the future, the First-Year Rate of Return (FYRR)* technique can be applied as an investment timing criterion. The FYRR is calculated by dividing the year-one worth of the benefits accruing in the first year of operation (i.e. the year subsequent to project completion) by the present worth of the investment cost involved, expressed as a percentage. If the FYRR is higher than the prescribed discount rate, then the project is timely and should go ahead right away. If the FYRR is lower than the prescribed discount rate, but the NPV is positive, commencement with project implementation should be postponed. In the situation where budgetary constraints limit the construction programme, the FYRR can be used as an aid to prioritise the projects showing similar degrees of viability (Layard and Glaister, 1994).

Suppose that the present worth of the investment is C_0, i is the annual discount rate expressed as a decimal fraction, and the net benefits in the following years are N_1, N_2,..., N_T, where T is the time horizon. Then the PW of the project would be:

$$-C_0+\frac{N_1}{(1+i)}+\frac{N_2}{(1+i)^2}+...+\frac{N_T}{(1+i)^T}.$$

If implementation is delayed by one year, the PW of the project would be:

$$-\frac{C_0}{(1+i)}+\frac{N_2}{(1+i)^2}+...+\frac{N_{T+1}}{(1+i)^{T+1}}.$$

Ignoring the PW of the benefits in the final year, N_{T+1}, the gain from a year's delay is:

$$-\frac{C_0}{(1+i)}+C_0-\frac{N_1}{(1+i)}.$$

This will be positive if

$$\frac{N_1}{C_0}<i.$$

The quantity on the left of this expression is the FYRR. If the FYRR is less than the rate of discount and the benefits of one year's delay exceed the costs then the project should be delayed. In doing so, the value of the project will increase. Delaying may also have other advantages in that more information may become available, or some adverse and unforeseen factor may emerge.

4.2 Capital Recovery Period technique

By taking into account the time value of money, the Capital Recovery Period (CRP)* technique provides a yardstick for estimating the period over which the project's investment will be recouped. The quicker this return, the greater the preference for a project. The CRP is the period over which the discounted benefits are equivalent to the investment cost. The CRP technique can be expressed as follows (Pienaar, 2002):

$$CRP = n$$

$$\text{When } C_0 = \sum_{t=k}^{n} \frac{N_t}{(1+i)^t}$$

Where:

CRP = capital recovery period
n = number of years over which the discounted benefits are equivalent to the capital investment
C_0 = present worth of the investment cost
t = any particular year in the CRP
k = first year of operation (i.e. the year following the end of the construction period)
N_t = year-end value of benefits in year t
i = annual rate of discount expressed as a decimal fraction

As it is an instrument to show how long it will take to recover total investment, the CRP technique does not purport to be a direct measure of viability. It is useful, however, for indicating the potential risk of projects – the sooner an investment is recovered, the sounder the project. In situations where budgetary constraints limit the construction programme, the CRP technique can be used as an aid to prioritise those projects showing similar degrees of viability (more so if their initial costs do not vary significantly) on account of their capital recovery period.

With respect to the handling and interpretation of the CRP technique, it should be noted that, firstly, the CRP is measured from the beginning of year k until the instant when the investment is recouped, and not from year 0 (construction takes place between years 0 and k); and, secondly, year n does not necessarily imply an integer. Capital recoupment can (and will usually) occur at any moment within a specific year (i.e. any date within year t). However, with inexact forecasting a foregone conclusion, there is no sense in estimating the CRP to a closer degree than one-month accuracy – i.e. in effect to one decimal only.

5. CONCLUSIONS

The recommended decision rules for project choice differ. Depending on whether the budget is fixed or variable and whether the projects are divisible or indivisible, the following rules apply:

(i) **Divisible projects; fixed budget**: Allocate funds among projects so that their incremental benefits are equal.
(ii) **Divisible projects; variable budget**: Extend all projects until their incremental B/C = 1, i.e. the net benefit of incremental investments becomes zero.
(iii) **Indivisible projects; fixed budget**: Choose the project mix ($B – C > 0$) that maximises net benefits.
(iv) **Indivisible projects; variable budget**: Choose all projects with positive net benefits ($B – C > 0$).

Usually the combination of indivisible projects and a fixed budget is the given situation, so that rule (iii) applies. To establish the most beneficial ranking necessitates evaluating all technically feasible projects.

Whenever the opportunity presents itself to solve a specific problem with the investment timing of the solution project not being challenged by any independent projects elsewhere, the NPV measure is the preferred selection criterion. When a choice has to be made among a number of independent projects, given a fixed budget, the B/C ratio and IRR measures are the preferred criteria.

In order to maximise benefit subject to a fixed budget and with both mutually exclusive and independent projects to consider, a method of project choice based on the incremental principle is recommended. This method consists of the following seven steps:

(i) Determine the size of the budget. Where the size of the budget has been given, this requirement is met. Where some freedom exists as to the total budget amount available, the amount can be expanded incrementally, and the incremental benefits compared with the incremental expenditure to determine whether any expansion of the budget is justified.
(ii) Eliminate all projects that exceed the budget limit and all projects that do not satisfy the minimum acceptance criteria, as described above.
(iii) Determine which project has the highest B/C ratio within each group of mutually exclusive proposals.
(iv) From the projects under consideration initially, select the one with the highest B/C ratio.
(v) Reconsider the selection of the best project in each group of alternative projects by, firstly, reviewing all the more expensive projects and noting the incremental B/C ratios. Within each group of mutually exclusive projects the project with the highest incremental B/C ratio is identified and compared with the rest of the

independent projects. Secondly, the available budget is adjusted to reflect the effect of the projects already chosen, and all remaining projects that exceed the balance of the budget are omitted.

(vi) Repeat steps (iv) and (v) for as long as possible. The iteration process ends when the budget is exhausted or when no acceptable projects remain for consideration.

(vii) Consider adjustments to chosen projects when the budget is not completely exhausted and a small adjustment in a chosen project may provide incremental benefits.

In a situation where budgetary constraints limit the construction programme, the First-Year Rate of Return technique (FYRR) and/or the Capital Recovery Period technique (CRP) can be used as aids to prioritise projects showing similar degrees of long-run viability. The FYRR provides guidance with respect to the most beneficial time to implement proposed projects, whereas the CRP can be used as a risk indicator – the shorter the period over which the investment of a project will be recouped, the greater the preference for the project.

6. GLOSSARY OF TERMS

Benefit:cost (B/C) ratio: The present worth of the benefits of a project divided by the present worth of its investment costs. (All proposals with a ratio value greater than 1 are viable.)

Capital Recovery Period (CRP): The period over which the discounted benefits of a project are equivalent to its investment cost.

First-Year Rate of Return (FYRR): The benefits of a project accruing in the first year of operation (i.e. the year subsequent to project completion) expressed as a percentage of the worth of its investment costs at the time of project completion.

Incremental B/C ratio: The difference between the present worth of the benefits of a larger alternative project and the present worth of the benefits of a smaller project, divided by the difference between the present worth of the investment costs of the larger alternative project and the present worth of the investment costs of the smaller project. (The incremental B/C ratio is a measure that can be used to select the most beneficial mutually exclusive project. When the incremental B/C ratio between two alternatives exceeds a value of 1, a move from the smaller project to the larger project will be beneficial.)

Independent projects: Projects that fulfil different functions. They do not form alternatives to one another and are, therefore, not mutually exclusive. The selection of a certain (functionally) independent project can at most postpone, but not exclude, the selection of another (functionally) independent project.

Indivisibility: The nature of a factor of production which is only supplied in discrete amounts, not increasing or decreasing in quantity continuously. Energy or liquid raw materials, for example, are divisible but a piece of capital equipment will be available only in minimum-sized quantities.

Internal rate of return (IRR): The discount rate that will equalise the present worth of the investment costs of a project and the present worth of its benefits, i.e. the discount rate at which the net present value (NPV) of a project will equal a value of zero, or the B/C ratio will equal a value of 1. (A project that yields an IRR greater than the discount rate is regarded as viable.)

Mutually exclusive projects: Technically feasible projects that will fulfil the same function if implemented. Because they are substitutes or alternatives, the selection of any one of the proposals will exclude the need for others.

Net present value (NPV): The difference between the present worth of a project's benefits and the present worth of its investment costs. (If the present worth of a project's benefits exceeds the present worth of its investment costs, it has a positive NPV and is, therefore, regarded as viable.)

Present worth (PW): The worth of a specified future value or of specified values occurring in different time periods expressed as a single amount at the present moment (i.e. year zero). (Present worth is also known as 'present value'.)

Present worth of costs (PWOC): The sum of the present worth of the investment costs and the recurring costs (i.e. all operating costs).

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