project planning and management series

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The Project Planning and Management Series consists of a set of manuals and associated modules presenting practical approaches, tools and techniques for project planning and management. (See list on back cover). A product of the Government of Jamaica/USAID National Planning Project (1976-1980), the series was developed by the Project Development Resource Team (PDRT) of PAMCO for use in "action-training" workshops and reflects extensive experience in training and project development. All present PDRT members are contributing authors and have worked together in writing, revising and publishing the series. Special credits are due to Dr. Merlyn Kettering for design and development of the series; Dr. Bruce Brooks for writing final versions of many modules; Mrs. Marjorie Humphreys for assuming primary editing and production responsibility and for organizing draft papers into more useful materials; Mr. Lascelles Dixon, head of PDRT since 1979, for designing the cover and improving many of the illustrations; and Mrs. Christine Hinds and Miss Linette Johnson for typing the drafts and final manuscripts. Any comments on the series and its usefulness are welcome.

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MODULE 25

INTERNAL RATE OF RETURN

Bruce Brooks

A. *PREREQUISITES:* MODULE 20 - Cash Flow Analysis

MODULE 21 - Discounting

References: MODULE 22 - Net Present Worth

MODULE 24 - Benefit-Cost Ratio

MODULE 28 - Project Accounting

B. *DISCUSSION:*

One of the widely used measures of the economic and financial viability of projects is the Internal Rate of Return. It is one of three criteria usually used to judge the financial and economic viability of projects singly or relative to one another. The other measures that should also be used are:

NET PRESENT WORTH, (SEE MODULE 22), and

BENEFIT-COST RATIO ANALYSIS, (SEE MODULE 24).

Internal Rate of Return is a measure of the payoff of a project expressed in terms of a percentage of the outlays on the project. Therefore it is a discount rate that, when used, results in Net Present Benefits of zero.

There is no formula for computing the IRR. It is ascertained by trying a lower discount rate and a higher one and then interpolating between the two to determine what discount rate will yield a Net Present Worth of zero.

To determine whether the project is acceptable, the decision-makers must compare the project IRR with the opportunity costs of the project and then compare this project with other investment opportunities.

The required IRR for a project that is designed to benefit society as a whole (internal economic return) is based on the decision by the funding body whether the internal rate of return is sufficient or not. This is also true in relation to a project that is designed for an individual entity, a specific group, or a sector.

The IRR can be computed without deciding on a specific discount rate, but a judgment must be made regarding the discount rates that are likely to be on either side of the discount rate which will result in zero net

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present worth of project benefits and is also the discount rate or the Internal Rate of Return for the project.

An IRR for a project cannot be determined if there isn't at least one negative annual cash flow. For some projects there may be more than one discount rate that gives a zero net present worth, (Net Present Benefits - Net Present Costs = Net Present Worth). This usually occurs if there are large negative cash flows late in the project. But most projects will have a negative cash flow early in the project followed by a rising stream of benefits.

C. *PURPOSE:*

This measurement technique tells the decision makers what the anticipated percentage return on invested capital will be.

D. *USE:*

The IRR can be used to indicate the financial and economic worth of a single project and can also be used to put projects in rank order.

E. *DEFINITIONS:*

F. *LIMITATIONS:*

G. *ASSUMPTIONS:*

H. *OUTPUT:*

Output of Project IRR Analysis

The results of the IRR analysis gives a single figure measure, the per cent return on invested capital. This single percentage figure can then be used to judge the projects worth singly or in relation to other possible investment opportunities. If projects are being ranked in numerical order and being funded in this order, the one with the highest IRR will be funded first, the second highest IRR would be funded second, etc. But, a project being analysed may not attain the designated IRR level; i.e., 15% or perhaps 18%, therefore it should not enter into the ranking and should be dropped from consideration for funding.

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I. *STEPS FOR COMPUTING THE INTERNAL RATE OF RETURN OF A PROJECT*

Requirements for IRR Analysis

1. To calculate an internal rate of return on a project, a cash flow analysis must first be done. (SEE APPENDIX 20 - CASH FLOW ANALYSIS).

2. The internal rate of return that is acceptable must be specified. This should be based on the minimum rate of return that the funding agency believes is acceptable or on the opportunity cost of capital based on some knowledge of the rate of return realized on other investment projects.

3. The project data used in computing the cash flow needs to be carefully examined or the IRR analytical results may be erroneous. The use of data that is as free from error as possible is essential.

The process followed for computing the IRR for a project can be done either by:

(a) *the trial error process* which starts with a trial discount rate and uses the procedure outlined below for computing Net Present Worth. New discount rates are tried until one of them gives a Net Present Worth of zero; or

(b) *interpolation between Net Present Worth* at what is felt to be a low discount rate and at a discount rate that is believed to be above the IRR of return. It is advisable to use a spread of no more than 5% between the selected low and the selected high discount rates.

a) TRIAL AND ERROR METHOD

STEP 1. Determine the annual gross benefits and costs over the life of the project. This is the same procedure as was followed in doing a Cash Flow Analysis (SEE MODULE 20 - CASH FLOW ANALYSIS).

STEP 2. Decide on "trial discount rate" for the first trial set of computations. Select the trial discount rate by examining the pattern of the cash flow. If there are large negative cash flows during the initial years and a delay in benefit flows, then a relatively low IRR is indicated. The initial trail discount rate chosen should be 10% to 15%. If the project has immediate positive cash flows and benefits are not delayed more than one or two years, choose a high trial discount rate of 40% to 50%.

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Remember, if the cash flows are never negative during any year of the project then the IRR is infinite and cannot be used as a measure of a project's financial or economic worth.

STEP 3. Using the discount rate chosen in STEP 2, compute the Net Present Worth of the project using the trial discount rate. If the NPW is zero, the discount rate which was used in the trial computation is the internal rate of return for the project. This is not likely to occur and another discount rate will need to be chosen. The process is then repeated.

STEP 4. If the Step 3 computation results in an NPW of less than zero, a smaller discount rate should be chosen for the next trial. If the NPW is smaller by a relatively small amount, select a discount rate that is 10% less than the one used in the first trial (STEP 3). When the results of trial one results in a NPW greater than zero, then the discount rate used in the second trial should be raised by 10% or more depending in the amount that the trial NPW is greater than zero.

STEP 5. Repeat the computations to arrive at the NPW of the project using the second trial discount rate.

STEP 6. Continue computing the NPW of the project using higher or lower discount rates until both a positive and a negative NPW for the project results. The internal rate of return is between the higher discount rate and lower discount rate that results in a positive and a negative NPW for the project.

STEP 7. When a positive and negative NPW has been computed by using higher and lower discount rates, the next step is to interpolate below the two to arrive at the internal rate of return for the project.

b) *INTERPOLATION*

$$\text{Internal Rate of Return} = \text{Lower Discount Rate} + \text{Difference Between the Discount rates used} \left[\frac{\text{Present Worth of Cash Flow at lower discount rate}}{\text{Absolute difference between the present worths of the cash flow of the two discount rates.}} \right]$$

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This is an example of how the computations are made: Say the lower discount rate is 12%, and the higher discount rate is 17%. The difference is 5%. Also, previous computations using the 12% discount rate resulted in a present worth of the cash flow stream of +765 and the higher rate of 17% resulted in a present worth of the cash flow stream of -340.

(The absolute difference between the present worth of the cash flow is
765 + 340 = 1105.

(The absolute difference between the present worths of the two cash flows ignores positive and negative signs and the result is the sum of the two numbers).

$$IRR = 12 + 5 \frac{(765)}{(1105)} = 12 + 3.46 = 15\%$$

The internal rate of return is rounded to the nearest whole percent because the estimated costs and benefits cannot justify an implication of greater accuracy.

To reach a Net Present Worth of zero for this project the internal rate of return must be 15.46%.

Example of the Computation of the IRR for a Project

This is a small broiler production project. The discount rate used to arrive at present worth of costs and benefits is 15%. The life of the project is 10 years. Computation of IRR of this project is shown in ILLUSTRATION 1A and 1B on page

This computation reveals that the IRR on this project is 33%. The decision makers have determined that a 15% return on investment is comparable to returns on similar investments. Therefore the 33% return on investment for this project is well above comparable investment opportunities. However, it may not be as high as other projects' investment opportunities when similar computations of IRR is made for them. But if the cut-off point for investment has been determined as 15%, the IRR of this project easily qualifies.

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ILLUSTRATION 1

COMPUTATION OF INTERNAL RATE OF RETURN FOR A PROJECT

A. Estimated Gross Costs and Benefits for each year of A Project and Cash Flows in thousands of monetary units.

Year	Gross Costs	Gross Benefits	Cash Flows	Discounted Cash Flows at 15%
1	68	21	(47)	(40.89)
2	43	60	17	12.85
3	43	60	17	11.19
4	43	60	17	9.72
5	43	60	17	8.45
6	42	60	18	7.78
7	43	60	17	6.39
8	44	60	16	5.23
9	44	60	16	4.54
10	45	60	15	3.70
TOTAL				28.96

NPW = sum of DCF = 28.96

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B. Computation of Internal Rate of Return from Cash Flows using different Trial Discount Rates and Interpolation to reach NPW (Net Present Worth).

		Trial 1	*Trial 2*	*Trial 3*	*Trial 4*
Year	Cash Flow	DR 20% Cash Flow	DR 25% Cash Flow	DR 30% Cash Flow	DR 35% Cash Flow
1	(47)	(39.15)	(37.60)	(36.14)	(34.83)
2	17	11.80	10.88	10.06	9.33
3	17	9.84	8.70	7.74	6.90
4	17	8.19	6.97	5.95	5.12
5	17	6.83	5.58	4.57	3.79
6	18	6.01	4.72	3.73	2.97
7	17	4.94	3.57	2.70	2.07
8	16	3.71	2.69	1.97	1.46
9	16	3.10	2.14	1.50	1.07
10	15	2.43	1.61	1.08	.75
		17.70	9.26	3.16	(1.37)

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As noted in ILLUSTRATION 1B the NPW of the project declined toward zero as the discount rate increased to 30% and was less than zero or (1.37) when a 35% discount rate was used. So, the discount rate that will result in a NPW of 0 is between 30% and 35% which can now be determined by interpolation using the formula:

$$\text{IRR} = \text{Lower Discount Rate} + \text{Difference Between the Discount} \times \left[\frac{\text{Present Worth of the Cash Flow at lower Discount rate}}{\text{Absolute difference between the present worths of the cash flows of the two discount rates}}\right]$$

$$\text{IRR} = 30 + 5\left(\frac{3.16}{4.53}\right) = 30 + 5\,(.\,6976)$$

$$= 30 + 3.49 = 33.49 \text{ or } 33\%.$$

The internal rate of return for this project is 33% when rounded to the nearest whole percentage. With estimated costs and benefits any greater accuracy by carrying the .49 of a % is not indicated.

Earlier PDRT working papers relevant to this topic include "Criteria to test Project Worthiness: Project Analysis and Appraisal", M. Kettering, 1977 (25 pages).

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EXERCISE 1. INTERNAL RATE OF RETURN

This is an exercise on computation of the Internal Rate of Return for A Project when the discount rate, used to compute the NPW, is 20%.

You are given the following Project Gross Costs and Benefits. The annual cash flows for a project are discounted at 20%.

Year	Gross Costs	Gross Benefits
1	150	0
2	50	125
3	50	120
4	50	110
5	50	70
6	50	70
7	50	70
8	50	60

Do these things:

1. Compute the annual cash flows.
2. Discount the annual cash flows using a 20% discount rate.
3. Compute the Net Present Worth (NPW) of the project Net Cash Flows.
4. Compute the Internal Rate of Return for the Project.

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EXERCISE 2. COMPUTATION OF PROJECT INTERNAL RATE OF RETURN

Computation of Internal Rate of Return for a project when the discount rate on cash flows is 15%. Gross costs and benefits are as shown below.

Year	Gross Costs	Gross Benefits
1	660	40
2	80	420
3	80	380
4	80	200
5	80	200
6	80	200
7	80	200
8	80	180

Do these things:

1. Compute the annual cash flows.
2. Discount the annual cash flows using a 15% discount rate.
3. Compute the Net Present Worth (NPW) of the project Net Cash Flows.
4. Compute the internal rate of return for the project.

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Project Planning and Management Series.

MANUAL - I Planning for Project Implementation
MANUAL - P Project Planning
MANUAL - M Project Management
MANUAL - PF Pioneer Farm Implementation Planning

MODULES

1. Defining Project Objectives (Objective Trees)
2. The Logical Framework
3. Work Breakdown Structure
4. Activity Description Sheets
5. Project Organization
6. Linear Responsibility Charts
7. Project Scheduling - Bar Charts
8. Bar Charting for Project Control/Scheduling
9. Project Scheduling - Network Analysis
10. Milestones Description Charts
11. Resource Planning & Budgeting
12. The Role of PAMCO
13. Project Technology Analysis
14. Demand Analysis
15. Market Strategy Analysis
16. Project Area Analysis
17. Project Costs & Benefits
18. Project Profile
19. Financial Analysis
20. Cash Flow Analysis
21. Discounting
22. Net Present Worth Analysis
23. Cost-Benefit Analysis
24. Benefit-Cost Ratio Analysis
25. Internal Rate of Return
26. Social Analysis of a Project
27. Economic Analysis of Projects (including Border Pricing)
28. Financial Statements & Ratios
29. Project Selection & Ratios Analysis
30. Brainstorming
31. Decision-making System for Projects
32. Project Institutional Environmental Analysis
33. Ecological Analysis for Projects
34. Introduction to Contracts, Jamaican Contract Documents & Tendering Procedures
35. Selection & Use of Consultants
36. Project Documents for Planning & Implementation
37. Report Writing for Projects
38. Project Files
39. Formats for Pre-Feasibility & Feasibility Studies
40. Motivation of Employees and Personnel Evaluation
41. Design of a Project Management Control System
42. Evaluating & Forecasting Project Progress & Performance
43. Project Termination
44. Introduction to Lending Agencies
45. Organizing and Conducting Conference Meetings
46. Withdrawal of and Accounting for Loan Funds in the Financing of Projects